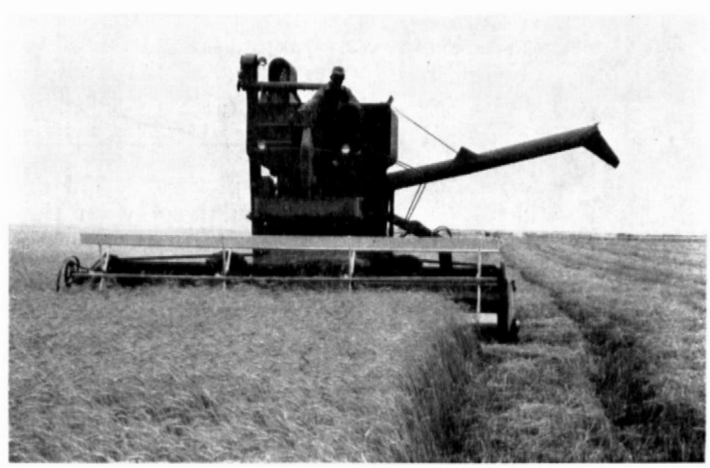
Series 1960, No. 11
Issued December 1963

SOIL SURVEY

Cotton County Oklahoma



UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
OKLAHOMA AGRICULTURAL EXPERIMENT STATION

HOW TO USE THE SOIL SURVEY REPORT

THIS SOIL SURVEY of Cotton County, Okla., will serve several groups of readers. It will help farmers in planning the kind of management that will protect their soils and provide good yields; assist engineers in selecting sites for roads, buildings, ponds, and other structures; aid foresters in managing woodlands; and add to our knowledge of soil science.

Locating Soils

Use the index to map sheets at the back of this report to locate areas on the large map. The index is a small map of the county on which numbered rectangles have been drawn to show where each sheet of the large map is located. When the correct sheet of the large map has been found, it will be seen that boundaries of the soils are outlined and that there is a symbol for each kind of soil. All areas marked with the same symbol are the same kind of soil, wherever they occur on the map. The symbol is inside the area if there is enough room; otherwise, it is outside the area and a pointer shows where the symbol belongs.

Finding Information

This report contains sections that will interest different groups of readers, as well as some sections that may be of interest to all.

Farmers and those who work with farmers can learn about the soils in the section "Descriptions of the Soils" and then turn to the section "Use and Management of Soils." In this way, they first identify the soils on their farm and then learn how these soils can be managed and what yields can be expected. The "Guide to Mapping Units, Capability Units, and Range Sites," at the back of the report will simplify use of the map and report. This guide lists each soil and land type mapped in the county and the page where each is described. It also lists, for each soil and land type, the capability unit and range site, and the pages where each of these is described.

Foresters and others interested in woodland can refer to the section "Woodland and Windbreaks." In that section the soils in the county are listed according to their suitability for windbreaks and postlots, and factors affecting the management of woodland and windbreaks are explained.

Engineers will want to refer to the section "Engineering Uses of the Soils." Tables in that section show characteristics of the soils that affect engineering.

Scientists and others who are interested will find information about how the soils were formed and how they are classified in the section "Formation, Morphology, and Classification of Soils."

Students, teachers, and other users will find information about soils and their management in various parts of the report, depending on their particular interest.

Newcomers in Cotton County will be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Nature of the County," which gives additional information about the county.

* * * * *

Fieldwork for this survey was completed in 1960. Unless otherwise indicated, all statements in the report refer to conditions in the county at that time. The soil survey of Cotton County was made as part of the technical assistance furnished by the Soil Conservation Service to the Cotton County Soil Conservation District. Farmers and ranchers in the county organized the Cotton County Soil Conservation District in 1949.

Cover pictures: The agriculture of Cotton County is based largely on the raising of cattle and the growing of wheat. The center picture shows the county courthouse at Walters.

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Contents

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SOIL SURVEY OF COTTON COUNTY, OKLAHOMA

BY WILLIAM J. RINGWALD AND OTHO W. LAMAR, SOIL CONSERVATION SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE

UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH THE OKLAHOMA AGRICULTURAL EXPERIMENT STATION

COTTON COUNTY is in southwestern Oklahoma (fig. 1). It has an area of 402,560 acres. The Red River forms the southern boundary of the county. Walters, the county seat, is 18 miles south of Lawton and about 100 air miles southwest of Oklahoma City.

The county is mainly agricultural. In 1959, approximately 186,015 acres was used to grow field crops, and 181,918 acres was in pasture. Wheat and cotton are the main cash crops.

Much of the acreage used for crops is subject to erosion by wind and water. There are also periods of drought when yields are obtained on only the best sites. In other years there may be ample moisture, and yields in those years are likely to be above average. Permanent pasture would be a better use for much of the acreage now used for cultivated crops.

The soils in this county developed in thick clay beds, in material weathered from sandstone, and in loamy material blown from the channel of the Red River. The soils that developed in clay beds have a compact, blocky subsoil that is slowly permeable. They are commonly known as hardlands. These clayey soils are less favorable for agriculture than the loamy soils, but they are suited to most of the crops commonly grown in the area.

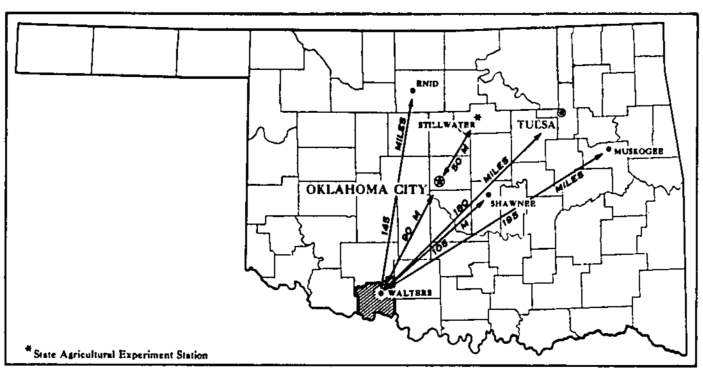

Figure 1.—Location of Cotton County in Oklahoma.

How Soils Are Named, Mapped, and Classified

Soil scientists made this survey to learn what kinds of soils are in Cotton County, where they are located, and how they can be used.

They went into the county knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dug or bored many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down to the rock material that has not been changed much by leaching or by roots of plants.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to uniform procedures. To use this report efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Foard and Port, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in natural characteristics.

Many soil series contain soils that are alike except for the texture of their surface layer. According to this difference in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Port loam and Port clay loam are two soil types in the Port series. The difference in the texture of their surface layers is apparent from their names.

Some soil types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into soil phases. The name of a soil phase indicates a feature that affects management. For example, Vernon clay, 1 to 3 percent slopes, is one of several phases of Vernon clay, a soil type that ranges from gently sloping to steep.

After a fairly detailed guide for classifying and naming the soils had been worked out, the soil scientists drew soil boundaries on aerial photographs. They used photos

for their base map because they show woodland, buildings, field borders, trees, and similar detail that greatly help in drawing boundaries accurately. The soil map in the back of this report was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil type or soil phase.

In preparing some detailed maps, the soil scientist has a problem of delineating areas where different kinds of soils are so intricately mixed, and in such small individual tracts that it is not practical to show them separately on the map. Therefore, he shows this mixture of soils as one mapping unit and calls it a soil complex. Ordinarily, a soil complex is named for the major soil series in it, for example, Lucien-Zaneis-Vernon complex. If two or more soils that do not occur in regular geographic association have differences too slight to justify mapping them separately, they are mapped together in an undifferentiated mapping unit. An example is Foard and Tillman silt loams, 1 to 3 percent slopes. Also, in most mapping, there are areas to be shown that are so rocky, so shallow, or so frequently worked by wind and water that they cannot be called soils. These areas are shown on a soil map like other mapping units, but they are given a descriptive name, such as Broken alluvial land, and are called land types rather than soils.

Only part of the soil survey was done when the soil scientist had named and described the soil series and mapping units, and had shown the location of the mapping units on the soil map. The mass of detailed information he had recorded then needed to be presented in different ways for different groups of users, among them farmers, managers of woodland and rangeland, and engineers.

To do this efficiently, he had to consult with persons in other fields of work and jointly prepare with them groupings that would be of practical value to different users. Such groupings are the capability classes, subclasses, and units, designed primarily for those interested in producing the short-lived crops and tame pasture; range sites, for those using large tracts of native grass; woodland suitability groups, for those who need to manage wooded tracts; and the classifications used by engineers who build highways or structures to conserve soil and water.

General Soil Map

After study of the soils in a locality and the way they are arranged, it is possible to make a general map that shows several main patterns of soils, called soil associations. Such a map is the colored general soil map in the back of this report. Each association, as a rule, contains a few major soils and several minor soils, in a pattern that is characteristic although not strictly uniform.

The soils within any one association are likely to differ from each other in some or in many properties; for example, slope, depth, stoniness, or natural drainage. Thus, the general soil map shows, not the kind of soil at any particular place, but patterns of soils, in each of which there are several different kinds of soils.

Each soil association is named for the major soil series in it, but, as already noted, soils of other series may also be present. The major soils of one soil association may also be present in another association, but in a different pattern.

The general map, showing patterns of soils, is useful to people who want a general idea of the soils, who want to compare different parts of a county, or who want to know the possible location of good-sized areas suitable for a certain kind of farming or other land use. Six of the nine soil associations in Cotton County are on the uplands, and the rest are on flood plains. All are described in the following paragraphs.

1. Foard-Tillman Association

Nearly level to gently sloping soils that have clayey subsoil; on uplands

The soils of this association occupy areas on broad, nearly level or gently undulating uplands (fig. 2). The areas are dissected by the Cache, Beaver, and Deep Red Creeks, which cross the county and empty into the Red River. The smallest area of soils in this association occupies about 1,200 acres, and the largest area, in the northwestern part of the county, occupies about 45,000 acres. This soil association makes up about 25 percent of the county, or approximately 102,000 acres.

The Foard soils make up about 42 percent of the association and occupy the more nearly level areas. They are brown to dark brown and have a clayey surface layer. Their subsoil is blocky, compact silty clay that is generally calcareous at a depth of 15 inches. The thickness of their surface layer ranges from about 6 inches in the western part of the county to about 12 inches in the eastern and southern parts. Organic matter has been lost from the surface layer through continuous cultivation. As a result, a thin, whitish crust has formed on the surface in some areas. This crust is more prevalent on the Foard soils in the western part of the county because the surface layer is thinner there. Also in the western part, where moldboard plows are used, part of the subsoil has been mixed with the surface layer by plowing. In the eastern part of the county, where there is slightly more rainfall, the lower layers are generally more grayish than those of the Foard soils in other parts of the county.

The Tillman soils make up about 50 percent of the association. They generally have long, gentle, single slopes. The Tillman soils are reddish brown and have a clayey surface layer. Their subsoil is blocky, compact clay and is generally calcareous at a depth of 12 inches. In most places these soils have a transitional layer of friable soil material between the surface layer and the subsoil. The transitional layer in some areas, however, has been mixed with the surface layer by plowing. Where the transitional layer has been mixed with the surface layer, the texture is slightly coarser than in other areas. In areas where the surface layer is thicker than normal, or where the soil has not been plowed deep enough to mix the material in the transitional layer with that in the surface layer, the texture of the surface layer is generally silt loam.

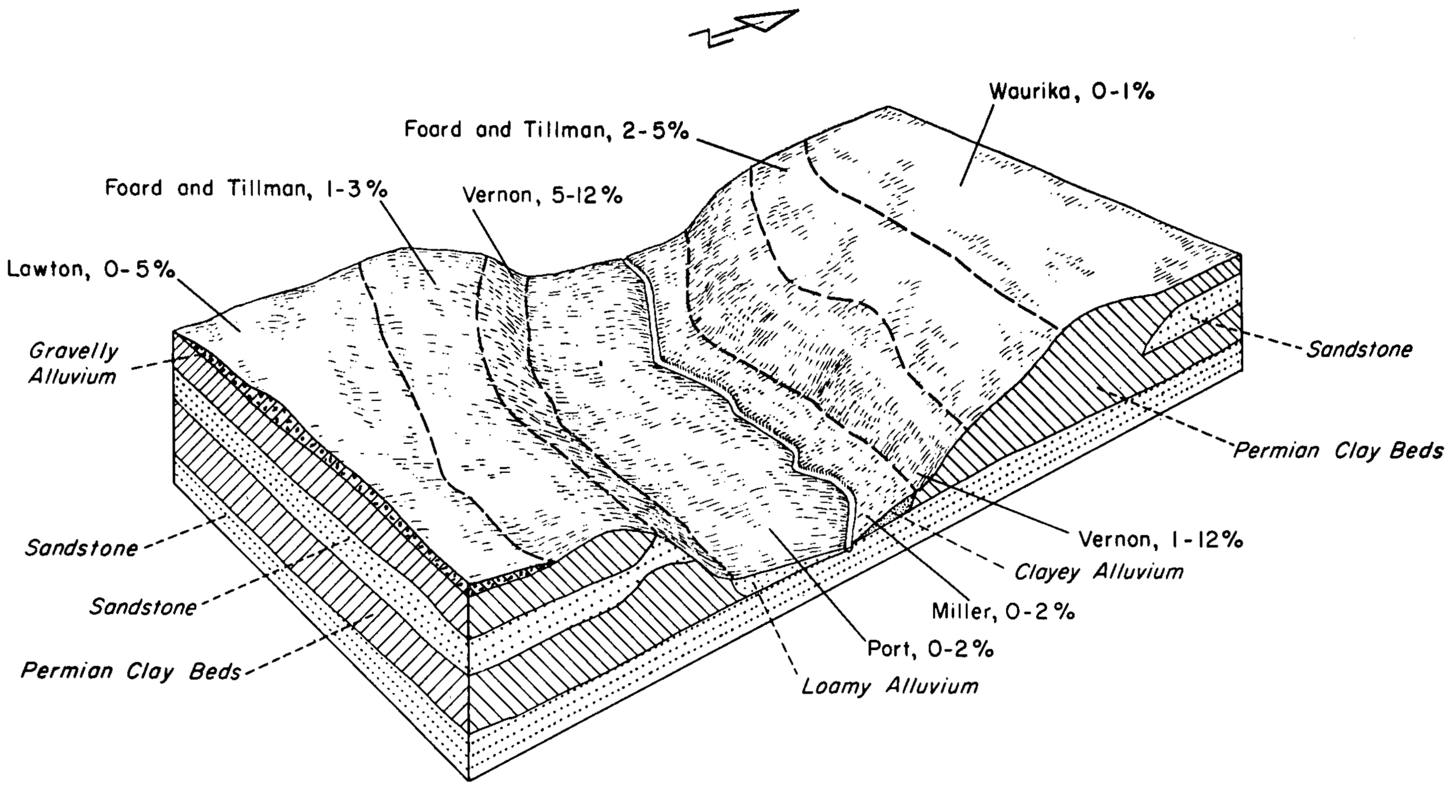

Figure 2.—**Typical pattern of the Foard and Tillman soils on gently undulating uplands in association 1.**

The Waurika soils make up a minor part of this association. They occur in slight depressions in the broad, nearly level flats in the eastern part of the county. Their surface layer is grayish-brown silt loam, and their subsoil is blocky, compact clay. The Waurika soils have a whitish, or leached, layer between the surface layer and the subsoil. This leached layer varies widely in thickness; it ranges from as little as 1 inch to as much as 4 inches within a distance of a few feet.

All of the soils in this association have a heavy, compact subsoil. They are difficult to till, and they lose moisture through runoff during heavy rains. Water erosion is a moderate problem on the gently sloping areas. Large, heavy machinery can be used without difficulty.

The soils in this association are well suited to small grains because moisture is more plentiful during the season when small grains make the greatest amount of growth than it is during the rest of the year. Most of the acreage is used to grow cultivated crops, and small grains are the crops grown the most extensively. Wheat makes good yields on the soils of this association, and it is the most extensive single crop grown. Some sorghum is grown, but it is planted mainly as a catch crop when other crops have failed. Cotton is also only a minor crop because the soils have a heavy subsoil that restricts the adequate development of roots. Also, the amount of rainfall is too low in summer for cotton to mature satisfactorily. The native plants that grow on the soils of this association are mainly buffalograss, blue grama, side-oats grama, and other short and mid grasses.

2. Zaneis-Lucien Association

Deep and shallow, moderately sloping soils of the uplands

This soil association consists mainly of moderately sloping soils of the uplands. Some areas are gently sloping, however, and the areas adjacent to the flood plains of the large drainageways are strongly sloping (fig. 3). The soils are subject to erosion. This association is in the eastern part of the county, nearly all of it east of Cache Creek. It occupies about 32,000 acres, or 7 percent of the county.

The Zaneis soils make up about 50 percent of this association. They are reddish, loamy, gently or moderately sloping soils that have a subsoil of clay loam. The Zaneis soils are alkaline and are generally calcareous at a depth of 46 inches. They occur in areas scattered throughout the eastern part of the county.

The Lucien soils are mapped in a complex with the Zaneis and Vernon soils. They consist of brownish very fine sandy loam or loam over fine-grained sandstone. The Zaneis soils in this complex have a surface layer of reddish, noncalcareous loam, and they have developed textural horizons. Their parent material of weathered sandstone and clay is at a depth of about 30 to 60 inches. The Vernon soils consist of reddish, calcareous clay, and they have no B horizon. They are less extensive in this association than the Zaneis and Lucien soils.

A small acreage in this association is made up of areas of other loamy soils that occur in irregular patterns. These loamy soils occupy a strip, ½ mile to 1 mile wide, which extends east of Cache Creek from U.S. Highway No. 70 to the Comanche County line. The soils also occur in a strip

of varying widths that borders the flood plains of Whiskey and Beaver Creeks. In some places they are in V-shaped drains that also contain narrow strips of bottom-land soils. In some places there are large, grayish, sandstone boulders on the surface. All the areas of these included soils are too small for the soils to be mapped separately, and they are included with the Lucien, Zaneis, and Vernon soils.

The Chickasha loams make up about 550 acres of this soil association. They are nearly level and are in the uplands. Their subsoil is dark-brown clay loam that is generally mottled with red and yellow below a depth of 30 inches.

The Zaneis soils are suited to small grains, sorghum, and cotton and are used extensively to grow those crops. They are among the best soils of the uplands for cotton and are well suited to wheat. In the Zaneis soils of this association, erosion has been moderate on about 3,500 acres and severe on about 400 acres. The severely eroded areas, for the most part, have been seeded to grass during the past few years.

The soils of the Lucien-Zaneis-Vernon complex have strong slopes and are generally used for range. The intricate pattern in which the soils occur and their strong to moderately strong slopes make them unsuitable for cultivated crops. They are fairly choice for range, however, and substantial amounts of forage are obtained. Mid and tall grasses are the dominant vegetation, but some short grasses grow on soils that have a clayey subsoil. Little bluestem is probably more extensive than other kinds of grass.

The soils in this association are susceptible to erosion. Therefore, they need to be protected by a cover crop during periods of high wind and high rainfall, and they should not be overgrazed.

3. Foard-Zaneis Association

Nearly level to moderately sloping soils of the uplands, some with slickspots

This soil association consists of nearly level to gently sloping soils of the uplands. The soils are characterized by slickspots, or areas where there is little or no vegetation. About 47,000 acres, or about 12 percent of the county, is in this association.

The Foard-slickspot complexes make up about 40 percent, or 19,100 acres, of this soil association. These soils are nearly level to gently sloping and have a crusted surface. Their surface layer is less than 8 inches thick and overlies a dark-brown subsoil of compact, blocky clay.

The Zaneis-slickspot complex occurs mainly in the eastern part of the county. It makes up about 60 percent, or 27,500 acres, of the association.

The surface layer of the Zaneis soil in this complex is as much as 12 inches thick in places, and in most places it overlies a subsoil of compact, blocky clay. If the Zaneis soils are cultivated, they are likely to lose all or part of their surface layer rapidly as the result of water erosion. Where the original surface layer has been lost, the clayey material that was formerly part of the subsoil becomes the surface layer. If the eroded areas of the Zaneis-slickspot complex are used for pasture or range, the areas where the slickspot soil occurs are conspicuous because of the lack of vegetation.

When rainfall is above average, fair yields are obtained on the soils of this association. When rainfall is average or below, only low yields are obtained because the salt in the soils makes the moisture unavailable to plants. The surface crust that forms on these soils reduces the penetration of water and hampers the emergence of seedlings.

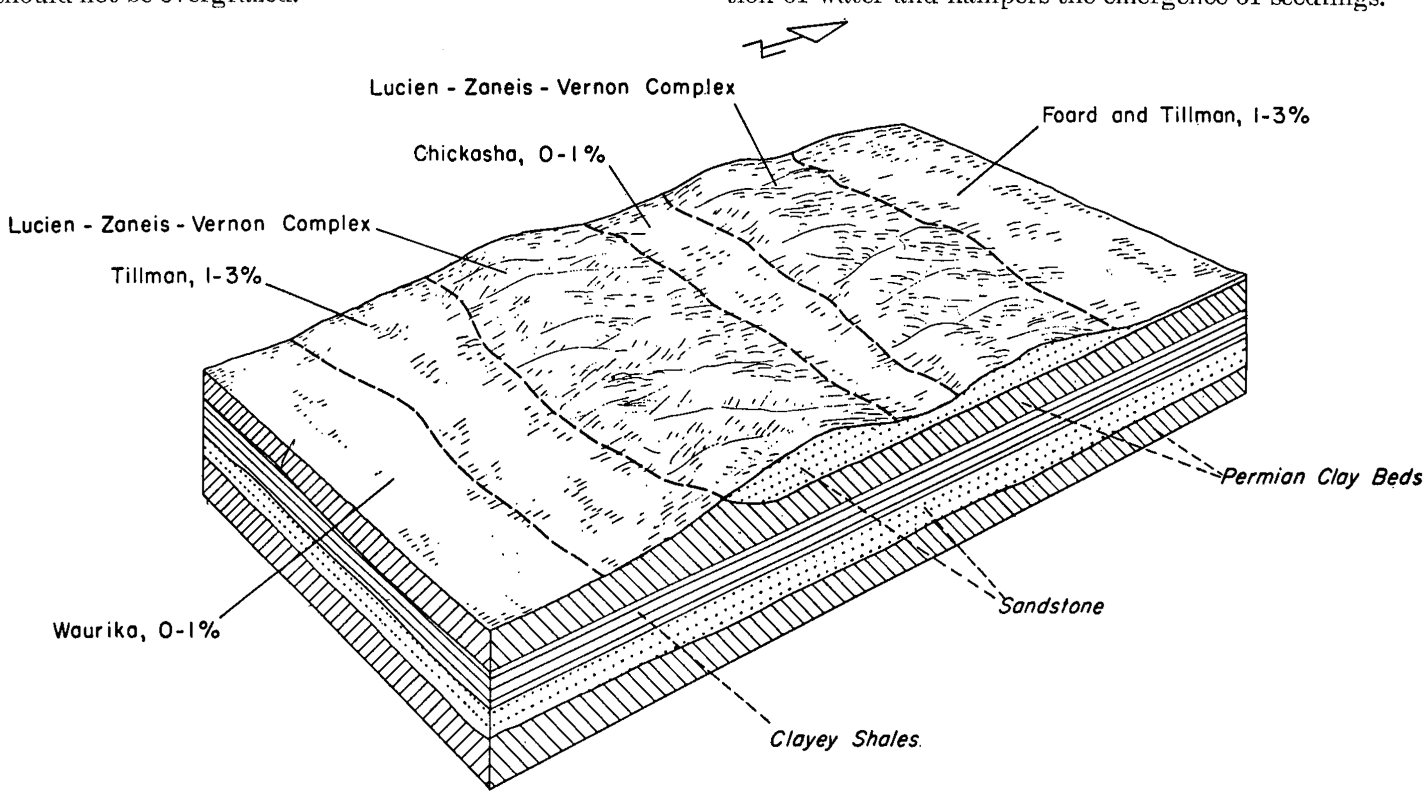

Figure 3.—**Typical pattern of Zaneis, Lucien, and associated soils in the northeastern part of Cotton County.**

4. Port-Yahola Association

Loamy soils of the flood plains

Some areas of this association are scattered along the Red River. Others are on the flood plains of the large creeks, except on the flood plains of Deep Red Run Creek, which are occupied by soils that are mostly clayey. The soils of the association are nearly level. In places they are dissected by small drainageways that are cut by meandering streams and that drain the surrounding loamy uplands. The association occupies about 66,700 acres, or about 13.5 percent of the county.

The Port soils make up about 79 percent of this association. Their surface layer is brownish, noncalcareous loam or clay loam that grades to reddish-brown, alkaline to calcareous clay loam at a depth of 15 inches or more. In places, and especially in the Port loam, these soils are stratified, and the layers differ in texture. There are also about 13,000 acres of Port soils in a complex with a slickspot soil.

The Yahola soils are reddish, calcareous loams. The lower layers of the Yahola soils contain somewhat more sand than the upper layers. These soils occupy the nearly level to undulating areas of the flood plain of the Red River. They have stratified lower layers that contain varying amounts of sand, silt, and clay. In low areas, or pockets, the texture of the surface layer is generally clay.

The soils in this association are subject to occasional flooding, and the floodwaters sometimes damage growing crops. The Yahola soils along the river are subject to scouring by floodwaters, and fresh material is then deposited on the surface. The areas along the river cave in if the streambanks are not stabilized. In 1960, about 60 acres of Yahola soils was lost in that way. The Yahola soils are also susceptible to wind erosion. They need to be protected at all times by a cover of plants.

The soils in this association are the most productive of the soils of bottom lands in the county. They are used primarily for cultivated crops, mainly small grains, sorghum, cotton, and alfalfa. The soils are suited to tall grasses, but they are used for range only when there are many areas of the slickspot soil, or overflows are frequent enough to lower the value of the soils for cultivated crops. Oaks, elms, and pecan trees grow in open stands along the streams in the association. Of these, pecan trees are the most desirable; substantial yields of pecans are obtained under good management. Areas of saltcedar and cottonwood trees are common on the Yahola soils.

5. Miller Association

Clayey soils of the flood plains

This association consists only of the Miller soils and of small areas of soils of the bottom lands that were mapped with the Miller soils. The soils of the bottom lands are along local drainageways.

The Miller soils are red, calcareous, and clayey. They overlie compact, clayey deposits from the red beds of Permian age, and they lose large amounts of rainfall as runoff. These soils occur extensively on the flood plains of Deep Red Run Creek, which drains the soils on plains in the uplands. They also occur in small, scattered areas along the flood plains of Beaver Creek. The channel of Deep Red Run Creek is fairly shallow and is not capable of carrying all the runoff water from this watershed. In most places the flood plain is about 1 mile wide and is dissected by small channels that drain the local uplands. Deep Red Run Creek and the small local drainageways are bordered by elm, oak, and pecan trees. Nuts from the native pecan trees furnish additional income for the farmers in the county.

Nearly all of the acreage in this association is subject to flooding. The floodwaters cause the soil material in the surface to run together and form a crust. The crust hampers the emergence of seedlings and prevents water and air from entering the soil. It is necessary to till the soils when they are neither too wet nor too dry.

The larger areas of this soil association are used extensively for cultivated crops, but some areas have been so cut by streams that they are too small for practical use. Wheat is the main crop grown, and high yields are common during favorable years. The plants in areas of pasture are mainly buffalograss, blue grama, white tridens, and other short grasses. Some of the areas that are frequently flooded have a sparse to moderate cover of mesquite.

6. Enterprise-Tipton-Lawton Association

Loamy soils of the uplands

The soils of this association occupy old, nearly level to strongly sloping, high terraces along the Red River. They also occur in scattered patches in areas along Cache Creek and West Cache Creek. These areas are near the courses of former drainageways that spread out as they extend farther from the mountains into the plain. The association occupies about 32,400 acres, or about 8 percent of the county.

The Enterprise and Tipton soils occupy the smooth, more nearly level, high terraces along streams. They occur in a continuous band that is generally about 1 mile wide and is located along the southern part of the county. This band is dissected by Cache and Whiskey Creeks. The Enterprise and Tipton soils are separated from the bottom lands of the Red River by steep slopes.

The Enterprise soils make up about 33 percent of this association. These soils are brownish very fine sandy loams that have no developed textural horizons. They are mainly nearly level and are in smooth areas that join the areas of dunes and steep slopes on the south. About 1,400 acres of strongly sloping Enterprise soils, however, are along bluffs and drainageways. In these areas drains have cut down through the mantle of windblown sediments, and the red-bed material outcrops in many places on the side slopes or bottoms. These soils formed in windblown material deposited over the clays of the Permian red beds.

The Tipton soils occupy about 9,900 acres in this association. They are brownish, loamy soils that have a subsoil of light clay loam. They are nearly level to gently sloping and are in broad areas adjacent to the Enterprise soils. The surface layer of the Tipton soils is less sandy than that of the Enterprise soils, and their subsoil contains more clay. The Tipton soils formed in silty alluvial sediments and in loamy windblown deposits.

The Lawton soils occupy about 11,800 acres in the county, and most of the acreage is within this association. They are in areas of various sizes scattered along Cache

Creek and West Cache Creek. The largest of these areas is just north of the place where West Cache Creek and Cache Creek join. The Lawton soils are brown to dark-brown, loamy soils that are noncalcareous. They formed in noncalcareous, old, gravelly alluvium and have granitic sand and small pockets of gravel in many places throughout the profile. In some places there are very gravelly layers at varying depths. The gravel is not loose and porous, and it contains enough fine particles of soil material that it has good moisture-holding capacity. About 2,300 acres of Lawton soils in this association are moderately eroded. The eroded areas are moderately sloping and have more runoff than the less sloping Lawton soils. Most of these eroded areas have been seeded to native grass during the past few years.

In about 800 acres of the association is a soil that has a surface layer of grayish-brown loamy sand and a subsoil of yellowish-red sandy loam. This soil formed in granitic outwash that was deposited more recently than that underlying the typical Lawton loams. In places it is on the flood plains of creeks, but generally the areas border the flood plains.

The soils of this association are well suited to the principal crops grown in the county. Most are used for cultivated crops, which make high yields. They are among the best soils for cotton in the county. The native vegetation is largely mid and tall grasses, which produce large amounts of forage. Good practices are needed to help prevent soil erosion. A tillage pan tends to form in the Enterprise and Tipton soils. Therefore, these soils should not be plowed when they are too wet, nor should they be plowed to the same depth year after year.

7. Pratt-Tivoli Association

Sandy soils of the uplands

This association consists of soils that occupy undulating to duny positions just above the flood plain of the Red River (fig. 4). The largest area is in the southwestern part of the county in a strip about ½ mile to 1 mile wide. This strip extends westward from a point northeast of the bridge across the Red River on U.S. Highway Nos. 277 and 281 to the Tillman County line.

The Pratt soils make up about 70 percent of this association. They are brown, gently sloping loamy fine sands. The texture of these soils is the same throughout the profile, and their color is only slightly lighter in the lower part of the profile than in the surface layer.

The Tivoli soils occupy about 2,300 acres and are mapped with the Pratt soils in an undifferentiated mapping unit. They have a surface layer of brown fine sand or loamy fine sand that grades to reddish-yellow fine sand at a depth of 6 to 12 inches.

Mapped with the Pratt and Tivoli soils are small areas of a soil that has a surface layer of loamy sand. This soil formed in granitic outwash. It occupies about 115 acres in the northern part of the county along West Cache Creek. Although this included soil is more nearly level than the Pratt and Tivoli soils, it requires the same kind of management. The areas are too small to be mapped separately.

The soils in this association have low water-holding capacity, but little rainfall is lost as runoff. These soils support tall grasses well because they yield soil moisture readily. They are used primarily for range, but the more nearly level areas of Pratt soils are used to grow cotton and sorghum.

The Pratt and Tivoli soils will blow if a surface cover is not maintained. The areas that have been overgrazed have thick stands of sand sage, yucca, and low shrubs, and nearly all of these areas have small, scattered stands of wild plum. Cottonwood trees are common in low areas where this association occurs in the eastern part of the county.

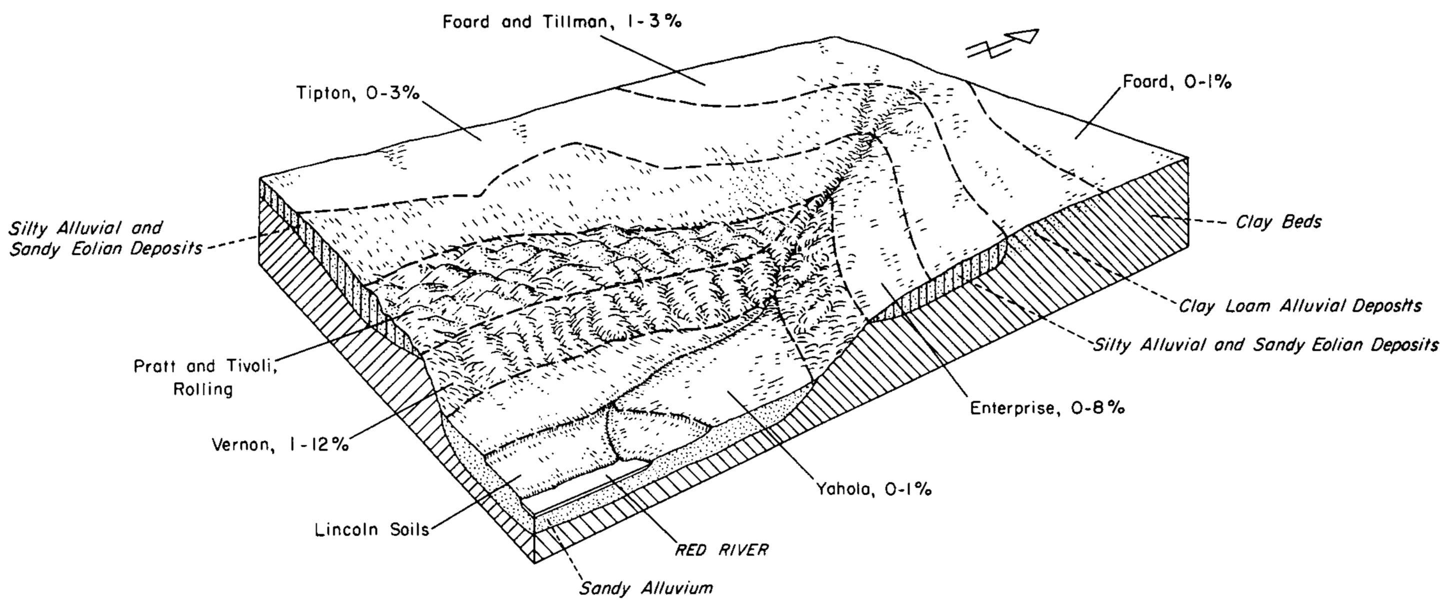

***Figure 4.*—Typical pattern of Pratt, Tivoli, and associated soils.**

8. Vernon Association

Red clay soils of the uplands

This association consists mainly of soils of the Vernon series. These soils are generally moderately sloping to steep (fig. 5), but a few areas are gently sloping. The areas border bottom lands and small drains, mainly in the western and southern parts of the county. The association makes up about 19 percent of the county, or about 80,500 acres.

The Vernon soils are reddish brown and clayey, and they are calcareous. The texture of their surface layer is clay or clay loam. In a few places the gently sloping soils overlie shale or clay of the red beds at a depth of more than 25 inches. In most of the strongly sloping areas and in all of the steep areas, shale or clay is at a depth of less than 15 inches. The soils are shallow, mainly as the result of the very slow permeability of the clay and shale. The Vernon soils are very sticky when wet and tend to crack open when dry.

Included in this association, on broad flats below the hilly Vernon soils, is a large acreage of a soil that has a clayey surface layer. Within the areas of clayey soils are occasional bare spots. Also included in the association is about 360 acres of Rough broken land. The areas of Rough broken land are severely eroded and have few to many rocks on the surface. The rocks range from small scattered fragments to pieces the size of boulders. The areas of Rough broken land are nearly bare. The soil material on the broad flats has been washed from these bare spots.

These soils are moderately fertile, but they are very slowly permeable and lose fairly large amounts of rainfall as runoff. Consequently, most crops lack adequate moisture at some time during the growing season.

These soils are suited to ponds, reservoirs, and most other structures used to store water because they hold water well. In addition, they are generally in watersheds and are well suited to the location of such structures.

The deep, gently to moderately sloping Vernon soils are used for cultivated crops, mainly small grains. The steeper areas are more extensive than the less sloping ones, and they are used only for pasture. The dominant grasses on the Vernon soils are buffalograss, blue grama, and sideoats grama. In the southern part of the county, where some areas are covered by a shallow, loamy deposit of windblown material, there is a vigorous stand of little bluestem. The areas that have been overgrazed have a thick stand of mesquite trees.

9. Lincoln Association

Sandy soils of the flood plains

Most of this association is made up of Lincoln soils. These soils occupy about 9,600 acres along the Red River.

The Lincoln soils generally have a light-brown, calcareous, sandy surface layer. In low areas or pockets, however, their surface layer is clayey. The texture of the lower layers is generally moderately coarse sand. These soils are stratified, however, and there are layers of almost every kind of texture. The water table is fairly high, generally within reach of deep-rooted plants. In places salt accumulates in the surface layer. The bare areas of these soils are highly susceptible to blowing.

The soils in this association are not suited to cultivated crops, and all of the acreage is used as range. Good yields of tall grasses are obtained, but the soils are unstable, because they are subject to scouring by floodwaters. They are also affected by the shifting of the stream channel. In some places sand is mined for use in concrete.

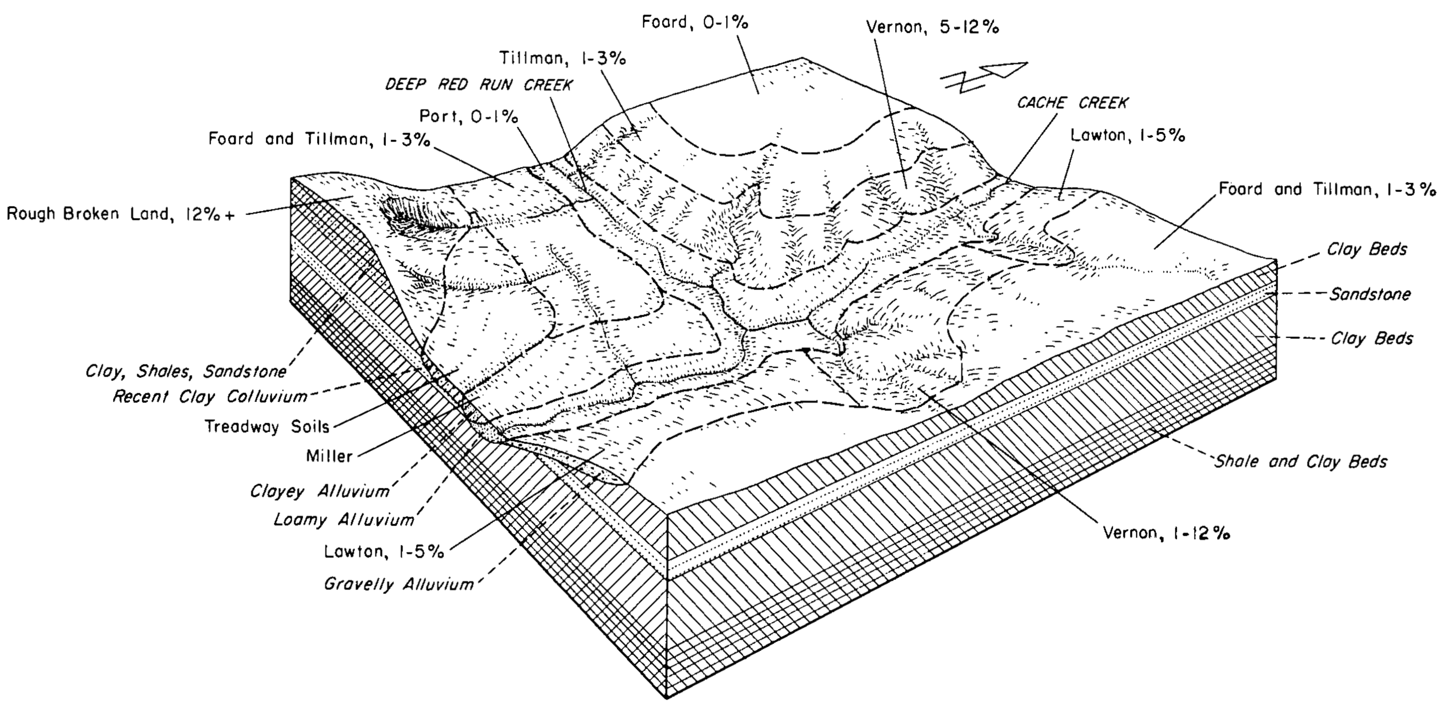

Figure 5.—**Typical pattern of moderately sloping Vernon soils in association 8.**

On this association are open stands of saltcedar, willow, and cottonwood. Tall native grasses, inland saltgrass, and bermudagrass grow on the open areas.

Descriptions of the Soils

In this section the soil series and mapping units are described and the relationship of the soils to agriculture is given. The acreage and proportionate extent of the soils are shown in table 1.

The soil series and the mapping units are described in alphabetical order. In the descriptions that follow, each soil series is first described, and then the soils in the series. The series description gives features that apply to all the soils of the series.

Following the name of each soil, there is a set of symbols in parentheses. These identify the soil on the detailed map at the back of this report. In addition, at the end of each soil description the capability group and the range site are given for each mapping unit. The capability units and range sites are described in the section "Use and Management of Soils."

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil	Area	Extent
	Acres	*Percent*
Breaks-alluvial land complex	1, 743	0. 4
Broken alluvial land	10, 335	2. 6
Chickasha loam, 0 to 1 percent slopes	540	. 1
Enterprise very fine sandy loam, 0 to 1 percent slopes	4, 874	1. 2
Enterprise very fine sandy loam, 1 to 3 percent slopes	3, 851	1. 0
Enterprise very fine sandy loam, 3 to 5 percent slopes	537	. 1
Enterprise very fine sandy loam, 5 to 8 percent slopes	1, 461	. 4
Eroded clayey land	904	. 2
Foard silt loam, 0 to 1 percent slopes	50, 277	12. 5
Foard-slickspot complex, 0 to 1 percent slopes	6, 221	1. 5
Foard-slickspot complex, 1 to 3 percent slopes	12, 933	3. 2
Foard and Tillman silt loams, 1 to 3 percent slopes	58, 844	14. 6
Lawton loam, 0 to 1 percent slopes	1, 541	. 4
Lawton loam, 1 to 3 percent slopes	5, 655	1. 4
Lawton loam, 3 to 5 percent slopes	2, 229	. 6
Lawton loam, 3 to 5 percent slopes, eroded	2, 368	. 6
Lincoln soils	9, 663	2. 4
Lucien-Zaneis-Vernon complex	14, 528	3. 6
Miller clay	12, 308	3. 1
Port clay loam	26, 308	6. 5
Port loam	12, 795	3. 2
Port-slickspot complex	12, 947	3. 2
Pratt loamy fine sand, undulating	2, 537	. 6
Pratt and Tivoli soils, rolling	5, 473	1. 4
Rough broken land	359	. 1
Shellabarger loamy sand, 0 to 4 percent slopes	821	. 2
Tillman silt loam, 1 to 3 percent slopes	5, 190	1. 3
Tipton loam, 0 to 1 percent slopes	3, 799	. 9
Tipton loam, 1 to 3 percent slopes	6, 127	1. 5
Treadway soils	4, 230	1. 0
Vernon clay, 1 to 3 percent slopes	1, 701	. 4
Vernon soils, 3 to 5 percent slopes	24, 439	6. 1
Vernon soils, 5 to 12 percent slopes	48, 410	12. 0
Waurika silt loam	888	. 2
Yahola fine sandy loam	2, 633	. 7
Zaneis loam, 1 to 3 percent slopes	10, 746	2. 7
Zaneis loam, 3 to 5 percent slopes	1, 151	. 3
Zaneis loam, 3 to 5 percent slopes, eroded	3, 567	. 9
Zaneis soils, severely eroded	414	. 1
Zaneis-slickspot complex, 1 to 3 percent slopes	27, 213	6. 8
Total	402, 560	100. 0

For a more detailed description of the soil series, and to learn about their classification and their relationship to the great soil groups, turn to the section "Formation, Morphology, and Classification of Soils."

Breaks and Alluvial Land

These land types consist of areas that have been cut by drainageways. Breaks consists of soil material on short, steep slopes. Alluvial land occupies narrow bottoms along streams. The areas occur along the upper reaches of natural drainageways, which are tributaries of the larger streams.

Breaks-alluvial land complex (Ba).—This soil complex consists of areas of Breaks and of alluvial land that are too small and intermingled to be mapped separately. It occurs throughout the county. On the side slopes, or areas of Breaks, the soil material is shallow to moderately deep over bedrock and has a texture of clay or clay loam. At the top of the side slopes the soil material is deep and has a clayey texture in the lower part. Alluvial land occupies the narrow strips of bottom land along small tributary streams. There are a few areas of a slickspot soil, but these make up less than 10 percent of the total acreage.

This complex is better used for grazing than for cultivated crops. Some attempts have been made to cultivate it, however, in areas that are within the boundaries of a cultivated field. Short and mid grasses and some mesquite trees make up the plant cover in areas that are grazed. (Capability unit VIe–5; Loamy Bottom Land, Red Clay Prairie, and Hardland range sites.)

Broken Alluvial Land

This land type is on the narrow flood plains of minor streams. The areas are dissected by the meandering channels of streams.

Broken alluvial land (Bd).—This land type is along the smaller creeks and tributaries and is subject to frequent flooding. In general, the flood plains are less than 400 feet wide. There are few, if any, smooth areas larger than about 5 acres between the stream channels. This land type consists mainly of silt loam and clay loam, but it includes small strips where the soil material is sandy loam or clay.

Broken alluvial land is probably best suited to grazing. It is generally not suited to field crops, because the areas are small and inaccessible. Native tall grasses are the dominant vegetation, and they occupy the open spaces. In places there are stands of hardwoods. (Capability unit Vw–2; Loamy Bottom Land range site.)

Chickasha Series

The Chickasha series consists of dark grayish-brown soils of the uplands. The soils developed in silty or sandy material weathered from sandstone or sandy shale of the red beds. They are nearly level and occupy smooth areas in the east-central part of the county (fig. 6).

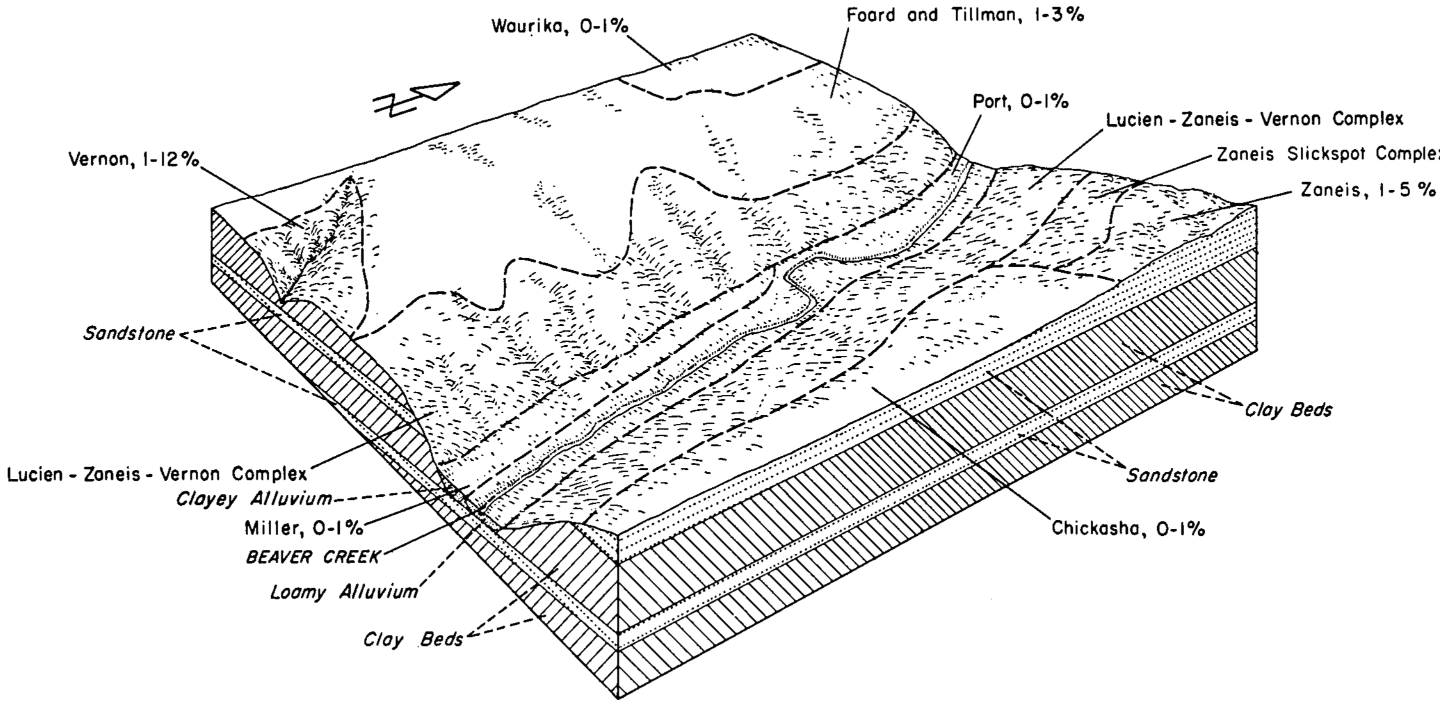

***Figure 6.*—Schematic diagram showing the location of the Chickasha and other extensive soils in the east-central part of Cotton County.**

The surface layer is 10 to 14 inches of dark grayish-brown, friable loam that has granular structure. The subsoil is dark-brown, friable or firm clay loam that has a few, fine, distinct mottles of reddish brown. Its structure is moderate, medium, subangular blocky. The parent material is pale brown and has distinct, reddish mottles. It begins at a depth of 40 to 60 inches and extends downward to weathered sandstone, which is at a depth of 4 to 7 feet.

These soils occur with the Zaneis and Waurika soils. The Chickasha soils are more nearly level and less red than the Zaneis soils. They also contain more sand than those soils and generally are thicker, have a better developed profile, and are more acid. The Chickasha soils have a surface layer and a subsoil that are less dark than those of the Waurika soils, and they lack a claypan in the subsoil.

The Chickasha soils are well drained, absorb water readily, and have a moderate water-holding capacity. Permeability is moderate to slow. The surface layer is medium acid, and the subsoil and substratum are slightly acid or neutral. These soils are easy to work and are susceptible to wind erosion only when the surface is not protected with crop residues.

The Chickasha soils are among the most productive soils in the county. Good yields are obtained in areas used to grow wheat, cotton, sorghum, and alfalfa. The soils are suited to peanuts, although that crop is not grown extensively. They are also well suited to tame and native pastures. The plants in the native pastures are mainly big and little bluestem, switchgrass, and Indiangrass.

Chickasha loam, 0 to 1 percent slopes (ChA).—This is the only Chickasha soil mapped in the county. The most important requirement in managing this soil is maintaining the supply of plant nutrients and a favorable soil structure. Cover crops should be grown and stubble-mulch tillage used to help control wind erosion. The soil is suited to all the crops commonly grown in the county. (Capability unit I–1; Loamy Prairie range site.)

Enterprise Series

The Enterprise series consists of brown, sandy soils on uplands or high terraces above and adjacent to the flood plains of the Red River. The soils developed in thick, calcareous material blown from the channel and flood plains of the river. They occupy a band, 1 to 2 miles wide, that extends from east to west across the county. Their slope is as much as 8 percent.

The surface layer of these soils, in an area that is nearly level, is about 16 inches of brown to dark-brown, friable very fine sandy loam. It has a weak, granular structure. The soil material below the surface layer is much like that in the surface layer, but it has a slightly lighter color. The entire profile is underlain by clay of the red beds, which is at a depth of 6 to 12 feet or more. In places along the river bluff, the clay is exposed.

The Enterprise soils occur with the Tipton and Tivoli soils. They have less distinct horizons than the Tipton soils and are coarser textured because they formed in coarser textured parent material. The Enterprise soils contain less sand and are not so loose as the Tivoli soils, and they are less strongly undulating or duny.

The Enterprise soils are well drained. They absorb water readily and have moderate water-holding capacity. Permeability is moderate. The soils have a neutral surface layer, and the soil material below the surface layer is mildly alkaline to calcareous. Free lime is generally at

a depth of 42 to 66 inches. These soils are easy to work, but they are susceptible to severe wind erosion if they are not protected by a cover crop and by crop residues.

These are among the most productive soils of the uplands in the county. Good yields are obtained in areas used to grow wheat, cotton, sorghum, rye, vetch, and Austrian winter peas. The soils are well suited to tame and native pastures. The plants in the native pastures are mainly little bluestem, big bluestem, switchgrass, and Indiangrass.

Enterprise very fine sandy loam, 0 to 1 percent slopes (ErA).—The main requirement in managing this soil is maintaining the supply of plant nutrients and favorable soil structure. Winter wheat or crop residues help protect the soil from wind erosion, and the wheat also supplies forage for winter grazing. This soil is well suited to irrigation.

This soil responds well to management, and it is suited to nearly all the crops commonly grown in the county. If it is used to grow small grains and alfalfa, phosphate and nitrogen are needed for the highest yields. Alfalfa also needs nitrogen if it is to make a vigorous stand. Row crops generally respond well if phosphate and nitrogen are added. (Capability unit IIc-1; Loamy Prairie range site.)

Enterprise very fine sandy loam, 1 to 3 percent slopes (ErB).—This is a gently sloping soil that needs protection from wind and water erosion. It is also necessary to maintain its supply of plant nutrients and favorable structure. The depth of tillage should be varied so that a dense, compact layer, or plowpan (fig. 7), is less likely to form.

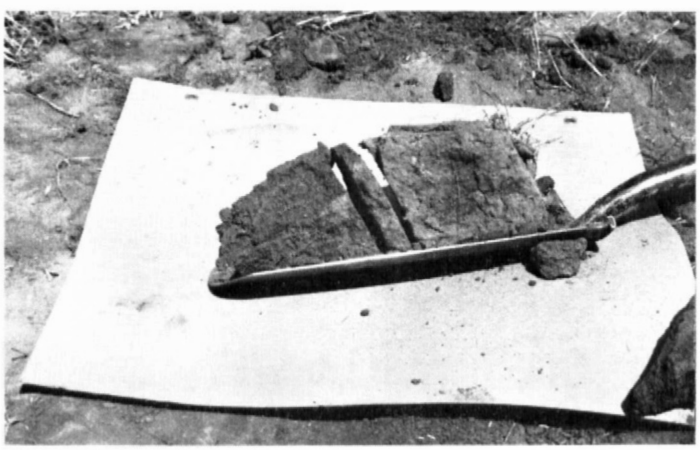

Figure 7.—**A plowplan, separated from the tilled soil above and the subsoil below, taken from an area of Enterprise very fine sandy loam, 1 to 3 percent slopes.**

This soil is suited to nearly all the crops commonly grown in the county. Most of it is used for cultivated crops, and some of it is irrigated. Alfalfa is not grown extensively, however, because the summers are dry and little water is available for irrigation. This soil is well suited to tame pasture. (Capability unit IIe-1; Loamy Prairie range site.)

Enterprise very fine sandy loam, 3 to 5 percent slopes (ErC).—This soil generally occupies areas adjacent to Enterprise very fine sandy loam, 1 to 3 percent slopes, but most of it is on the side that is farthest from the Red River. In places on the side nearest the river, it is adjacent to Yahola fine sandy loam.

Most of this soil is used to grow cotton and small grains. A few acres of alfalfa are grown, but the yields of small grains and of tame pastures are more dependable than those of other crops.

Good practices to conserve water and to protect the soil from erosion are constructing terraces and grassed waterways, tilling on the contour, and leaving crop residues on the surface. In seasons when there is ample moisture, a mixture of small grains and a legume can be plowed under as green manure before planting a summer crop. (Capability unit IIIe-1; Loamy Prairie range site.)

Enterprise very fine sandy loam, 5 to 8 percent slopes (ErD).—This soil is in areas similar to those occupied by Enterprise very fine sandy loam, 3 to 5 percent slopes. Its surface layer, however, is only about 4 to 8 inches thick because part of the soil material has been removed by erosion. The surface layer is underlain by a brown to reddish-brown subsoil. The substratum extends downward to the clays and clay loams of the red beds, which are at a depth of 5 feet or more.

This soil is strongly sloping, but it can be used for grazing or for perennial vegetation that does not require frequent cultivation. On this soil much water is lost through runoff. Practices to conserve water and to protect the soil from erosion are stubble-mulch tillage, cultivating on the contour, and constructing terraces in areas that are cultivated. These will help to increase infiltration.

Some areas of this soil have been seeded to native grasses. Bermudagrass grows well if proper amounts of fertilizer are added. (Capability unit IVe-1; Loamy Prairie range site.)

Eroded Clayey Land

Eroded clayey land consists of areas of soils that have been so altered by erosion that they have a different use than they did originally. Most of the areas are no longer used for cultivated crops, and they are suited only to grazing. Most of this land type is sheet eroded. There are some gullies, but most of them are shallow. The subsoil is clayey and resists gully erosion.

Eroded clayey land (Es).—This land type consists mainly of soils that were formerly in the Foard and Tillman series, but it includes some severely eroded areas of Vernon soils. It is mainly in the western one-half of the county.

This land type should be seeded to native grasses that grow well in the area. The areas that have not been seeded to native grasses support only weeds and grasses that are not palatable to livestock. Active erosion needs to be controlled.

Most of this land type has little or no useful vegetation. It is necessary, but difficult, to reestablish grass in the areas to help control erosion. Only a limited amount of forage can be expected, even if a cover of native grass is established. If diversion terraces are constructed to divert water from higher lying areas, they will help in establishing vegetation in the gullies. The plants to encourage in the native pastures are buffalograss, blue grama, and side-oats grama. (Capability unit VIe-1; Eroded Clay range site.)

Foard Series

The Foard series consists of deep, brown to dark-brown soils of the uplands. The soils developed in calcareous clays and clay loams from red beds of Permian age. They are nearly level to gently sloping and occur throughout the county.

The surface layer, in an area that is nearly level, is 6 to 12 inches of brown to dark-brown, friable silt loam. It has weak, granular structure. The boundary of the surface layer is abrupt. Below the surface layer is dark-brown clay that has moderate to strong, blocky structure. The parent material is yellowish red and is mottled in places. It is at a depth of 50 to 66 inches and extends downward to as much as 8 feet in some places.

The Foard soils occur with the Tillman and Waurika soils. They have about the same permeability as the Tillman soils and are suited to the same kinds of crops; they are less red, however, and are more nearly level. The Foard soils are generally more nearly level than the Waurika soils. In addition, their surface layer is normally less dark, and they lack the distinct, gray layer between the surface layer and the subsoil that is common in the Waurika soils.

The Foard soils are moderately well drained and are moderately fertile, but they are rather droughty. Their surface layer has a distinct tendency to crust. These soils absorb water slowly, and their subsoil is clayey and tends to release stored water to plants rather slowly. Permeability is very slow. The more sloping areas are susceptible to erosion, but the clayey subsoil keeps gully erosion from being a severe hazard. The surface layer is neutral, the subsoil is mildly alkaline, and the substratum is moderately alkaline. Free lime is at a depth of about 15 inches.

Good yields of wheat, oats, cotton, and sorghum are obtained on these soils in years of above-average rainfall. Austrian winter peas can also be grown. They increase the supply of plant nutrients and improve the tilth. The plants in native pastures grow well on these soils, but the carrying capacity of the pastures is limited. The main plants in the native pastures are side-oats grama, blue grama, buffalograss, and some little bluestem.

Foard silt loam, 0 to 1 percent slopes (FoA).—This is the only Foard soil mapped separately in the county. Some areas of a slickspot soil are included with this soil. In an area that has been cultivated year after year, the slickspot soil is lighter colored than the surrounding soils, and a thick crust tends to form on its surface after rains and between cultivations.

Foard silt loam, 0 to 1 percent slopes, has adequate drainage for some crops, but the amount of available moisture is often too low for crops to grow well in summer. The soil has a high moisture-storing capacity. Therefore, all practical methods should be used to increase the intake of water so that it can be stored for plants. Stubble mulching and turning under crop residues will keep the soil porous and will help to prevent crusting and sealing of the surface soil. Growing two crops in the same year is seldom, if ever, a good practice on this soil. Erosion is not a great problem.

Most of this soil is used to grow small grains, but some of the acreage is used to grow cotton and sorghum. The small grains respond to phosphate (fig. 8) and nitrogen if moisture is ample in spring. Row crops benefit if phosphate and nitrogen are added. (Capability unit IIs-1; Hardland range site.)

***Figure 8.*—Winter wheat growing on an area of Foard silt loam, 0 to 1 percent slopes. Phosphate was applied, in the amount indicated by testing the soil, on all plots except the check plot in the center.**

Foard-slickspot complex, 0 to 1 percent slopes (FsA).—This complex consists of areas in which Foard and slickspot soils are so intricately mixed that it is impractical to show them separately on a map. It occurs on broad, nearly level to gently sloping areas throughout the county, but it is mainly in the northern and western parts.

The slickspot soil makes up 10 to 30 percent of this complex. The surface layer of a nearly level slickspot soil has a severe crust 1 to 2 inches thick. In cultivated areas this crust appears glazed and whitish after rains. Below the crust, the surface layer is 4 to 6 inches of dark grayish-brown silt loam or light clay loam that has weak, granular structure or is structureless. The boundary between the surface layer and the subsoil is abrupt. The subsoil is 8 to 12 inches of a compact, blocky claypan. The blocks have a coating of clay on the surface, and the clay tends to seal out water, air, and roots. The substratum is similar to that of the Foard soils and is at a depth of 3 to 4 feet.

The soils in areas between the Foard and the slickspot soils have a surface layer that is similar to that of the Foard soils. Their subsoil is similar to that of the slickspot soil.

The soils of this complex are difficult to till. When they are used for crops, seeds do not germinate readily and the plants emerge slowly. The moisture in the soils is not readily available to growing plants. The soils are probably best suited to small grains or crops grown in cool seasons. The small grains make fair to good yields in years of above-average rainfall. In years when the amount of rainfall is small, however, yields are low and the crop sometimes fails.

These soils are not suited to row crops, because the summers are hot and dry. In addition, the soils are droughty and contain salt; and the surface crusts severely. Applying agricultural gypsum to the slickspot soil will help to reduce surface crusting, to increase the intake of water, and to improve the structure of the soil. The gypsum needs to be applied at the rate of 2 to 4 tons per

acre. If the areas are seeded to grass, the plants remain dormant during long, dry periods and, in places, the areas of slickspot soil remain bare. The main native plants on areas of the slickspot soil are buffalograss, alkali sacaton, and blue grama. (Capability unit IIIs-1; Hardland and Slickspot range sites.)

Foard-slickspot complex, 1 to 3 percent slopes (FsB).—This complex consists of Foard soils and of a slickspot soil. The areas are so intermingled it is impractical to show them separately on a map. The slickspot soil makes up 20 to 40 percent of the complex.

In areas that are cultivated, sheet erosion is a problem, but gully erosion is not severe. Constructing diversion terraces, cultivating on the contour, mulching, and growing crops that produce a large amount of residue will help to control erosion. Stubble-mulch tillage increases the amount of water that soaks in and decreases the amount of runoff. It also lessens the tendency of the soils to crust, and, as a result, plants can emerge more quickly. This complex is probably best suited to small grains, but many areas that were formerly cultivated have been seeded to native grasses (fig. 9). (Capability unit IVe-3; Hardland and Slickspot range sites.)

Figure 9.—An area of Foard-slickspot complex, 1 to 3 percent slopes, seeded to native grasses. The nearly bare areas are the slickspot soil.

Foard and Tillman silt loams, 1 to 3 percent slopes (FtB).—This mapping unit consists of areas of Foard silt loam and of Tillman silt loam so intermingled that it is impractical to show them separately on a map. The Foard soil makes up about 35 percent of the mapping unit, and the Tillman soil makes up about 65 percent. A profile that is typical of the Tillman soil is described under the Tillman series.

Some areas of Foard clay loam and of Tillman clay loam are mapped with these soils. Also included are some areas of a slickspot soil. The included areas are too small to be mapped separately.

The main requirements for managing Foard and Tillman silt loams, 1 to 3 percent slopes, are to maintain the supply of plant nutrients and favorable soil structure and to protect the soils from erosion. Practices are needed that will increase the intake of water, decrease runoff, and lessen the tendency of the soils to be droughty. In places sheet erosion is a hazard. It is not a great problem, however, if winter cover crops are grown and if stubble-mulch tillage, contour farming, and terraces are used.

Nearly all of the acreage is used to grow small grains and winter legumes. Row crops are suitable for these soils, but they are not grown extensively, because of periods of drought during the hot, dry summers. (Capability unit IIIe-2; Hardland range site.)

Lawton Series

The Lawton series consists of loamy soils that are nearly level to moderately sloping. The soils developed in noncalcareous loam and gravelly loam deposited by streams. The loamy material washed from areas underlain by granite in the Wichita Mountains. It ranges from 3 feet to many feet in thickness and overlies clays of the red beds. The soils occupy smooth areas along West Cache and Cache Creeks in the northern and western parts of the county.

The surface layer, in a gently sloping area, is 10 to 12 inches of brown to dark-brown, friable loam. It has moderate granular and moderate prismatic structure. The material in the surface layer grades to reddish-brown light clay loam that has granular structure and extends downward to a depth of 14 to 16 inches. Below this soil material is reddish-brown, firm clay loam that is moderately to slowly permeable. The parent material is yellowish-red clay loam and is at a depth of 50 to 60 inches. In most places there are numerous granitic pebbles throughout the profile. The pebbles are not numerous enough, however, to make the soils loose and very porous, and the soils have a good capacity for storing moisture.

The texture of the surface layer ranges from loam to very fine sandy loam, and its thickness ranges from 8 to 14 inches. In some sloping areas the original surface layer has been thinned, or all of it has been removed by erosion. In places where the original surface layer has been lost, reddish-brown clay loam that was formerly part of the subsoil makes up the present surface layer. In places the texture of the subsoil is light clay.

The Lawton soils occur with the Foard, Tillman, and Vernon soils. Their surface layer contains more loam than that of the Foard and Tillman soils, and they lack the subsoil of blocky clay that is common in those soils. Unlike the Vernon soils, which formed in a shallow layer of calcareous clay or clay loam over red, compact clay, the Lawton soils formed in deep, noncalcareous loam or gravelly loam. In some places, however, the Lawton soils have characteristics similar to those of the Vernon soils.

The Lawton soils absorb water readily and store moderate amounts of water for plants. Permeability is moderate to slow. The soils are easy to work, but there is a risk of erosion by water on the steep slopes.

These soils are among the most productive soils of the uplands in the county. They are used to grow wheat, oats, barley, and sorghum, and good yields are obtained. The soils are suited to cotton and alfalfa, but those crops are not widely grown. Forage plants, both in tame and in native pastures, grow well. The soils are suited to bermudagrass and blue panic grown for improved pasture. Big and little bluestem, Indiangrass, and switchgrass are the main plants in the native pastures.

Lawton loam, 0 to 1 percent slopes (LaA).—This soil has a profile similar to the one described for the Lawton series. In places, however, the surface layer is thicker. The main requirement in managing this soil is to maintain the supply of plant nutrients. This soil is suited to nearly all the crops commonly grown in the county. (Capability unit I–1; Loamy Prairie range site.)

Lawton loam, 1 to 3 percent slopes (LaB).—This soil is among the best agricultural soils of the uplands. It is moderately high in content of organic matter, and a large amount of water soaks into it. Good tilth is easy to maintain. Management should include practices, such as tilling on the contour and constructing terraces, that conserve moisture and protect the soil from erosion.

Most of this soil is cultivated, and some of it is irrigated. Wheat, oats, sorghum, cotton, and alfalfa are among the principal crops grown. These crops make good yields, as do forage crops grown for tame pasture. The crops respond well if proper kinds and amounts of fertilizer are added. (Capability unit IIe–2; Loamy Prairie range site.)

Lawton loam, 3 to 5 percent slopes (LaC).—This soil is in the central part of the county.

In some areas where clay beds are exposed or are near the surface, areas of Tillman soils, too small to be mapped separately, are included in the areas. The Tillman soils are generally in bands that run across the slope. Many areas of a slickspot soil develop in these included areas.

Lawton loam, 3 to 5 percent slopes, is suited to cultivated crops, but most areas are in pasture. In many places the pastures of native tall grasses are only fair and contain many undesirable grasses and weeds of low value for feed. If grazing is reasonably well managed, tall grasses grow well on this soil. Continued close grazing, however, causes the tall grasses to lose their vigor. Then short grasses will replace them. In many places close grazing and trampling have also reduced the capacity of the soil to absorb water. (Capability unit IIIe–1; Loamy Prairie range site.)

Lawton loam, 3 to 5 percent slopes, eroded (LaC2).—This soil has lost part of its original surface layer through sheet erosion. Its present surface layer is about 6 inches thick, or thinner than that of Lawton loam, 1 to 3 percent slopes. In most places the present surface layer is brown or reddish brown. It is reddish brown in areas that have been cultivated because part of the underlying light clay loam has been mixed with the original surface layer by tillage. The light clay loam, in some areas that have been cultivated, was exposed when terraces were constructed.

This soil loses a large amount of water through runoff. Therefore, it needs intensive practices designed to reduce runoff and to give protection from further erosion. Cultivating on the contour is a desirable practice, and stubble mulching should be used to keep the soil porous and to improve infiltration. Good tilth can generally be restored through proper management. Terraces are used in many places to divert runoff to protected channels. Where they are used, more of the water soaks in and the terraces also help to protect the soil from further erosion. The single practice of cultivating on the contour controls runoff if the water is directed to drainageways that are seeded to perennial vegetation and if cover crops and crop residues are properly utilized.

Most of this soil is used for cultivated crops, such as wheat and sorghum. The soil responds well if it is tilled and fertilized properly. If moisture is adequate, small grains and row crops respond well when nitrogen and phosphate are added. (Capability unit IVe–4; Loamy Prairie range site.)

Lincoln Series

The Lincoln series consists of stratified soils that have a surface layer of loamy sand to silty clay. The soils are on the flood plains of the Red River. They are 6 to 12 feet above the normal level of the water and occupy areas where the soil material is shifted about when the river changes its course. Most areas have probably been altered appreciably within the past 50 years. They have been scoured, or the depressions have been filled each time the river overflowed.

In places where the soil material has been shifted and redeposited by wind, it occurs in an irregular pattern of low ridges or dunes and intervening smoother areas. These low ridges result largely from wind action on the recent, sandy alluvium of the flood plain and river channel. The ridges that have a broad base are as much as 6 feet high, but they are only about 3 feet high in most places. This type of topography occurs in about 15 percent of the acreage; the rest has a wavy, choppy, or smooth surface.

The soil material in the dunes is sandy loam and silt loam. In slight depressions or swales between the dunes there is stratified clay loam, loam, and clay. The dunes and swales were parallel to the river at the time they were formed, but now their location is no longer related to the direction of flow.

Mapped with these soils are some areas of riverwash on which there is no vegetation. Most areas, however, are fairly well covered by johnsongrass and other coarse, tall grasses. Clumps of sandplum and other brushy plants grow on the low, sandy ridges. The swales are generally covered by smartweed, and some areas of the very sandy flats are covered by saltcedar. The areas that have been least disturbed have a scattered stand of cottonwood trees in some places, but the low, moist areas have a brushy growth of willow.

Lincoln soils (Ls).—The Lincoln soils in this county are mapped as one unit. These soils are wet for long periods after heavy rains or floods, and their use for crops is limited. They are probably best suited to grazing or as a refuge for wildlife. The soils should not be cultivated extensively, but some of the smooth, high areas that are well drained are used for crops during favorable seasons.

Areas that are flooded only infrequently can be used to grow locust and catalpa trees for fenceposts. Areas where there is sanding or silting should not be used for trees. (Capability unit Vw–1; Sandy Bottom Land range site.)

Lucien Series

The Lucien series consists of reddish, noncalcareous soils of the prairies. The soils developed under grass in material weathered from red, soft, noncalcareous, fine-grained sandstone and sandy shale.

The surface layer of these soils is 2 to 20 inches of brown to reddish-brown loam or very fine sandy loam. These soils are underlain by red sandstone (fig. 10); a few fragments of sandstone are on the surface and throughout the profile. The Lucien soils are not mapped separately in this county but are mapped with the Zaneis and Vernon soils.

Figure 10.—**An area of Lucien very fine sandy loam, showing layers of sandstone.**

Lucien-Zaneis-Vernon complex (Lz).—This complex consists of areas in which the Lucien, Zaneis, and Vernon soils are so intricately associated that it is impractical to show them separately on a map. The Lucien soils make up about 50 percent of the complex; the Zaneis soils, about 20 percent; and the Vernon soils, about 10 percent. The remaining 20 percent is occupied by a loamy soil that lies between areas of Lucien and Zaneis soils and has some characteristics of the soils of both series. Profiles that are typical of the Zaneis and Vernon soils are described under the Zaneis and Vernon series.

The areas of this complex are on sloping to steep ridges and along the Breaks in the prairie areas. The soils occur in rough bands around the slopes. The Lucien soils, which overlie sandstone, are at the top of slopes in the eastern one-half of the county. They grade to the Zaneis soils, which have a thicker solum than the Vernon soils and are in intermittent pockets that lie between outcrops of sandstone. The solum of the Zaneis soils is more than 20 inches thick.

The Vernon soils overlie beds of clay. They occur as narrow bands on side slopes and at the head of narrow drainageways. In many places their surface layer is loam that weathered from the sandstone of higher areas. The loamy soils in this complex are moderately permeable. In areas where the surface layer is porous, they absorb moisture readily.

The Lucien soils do not have a large capacity for storing water, but tall grasses on these and on the other loamy soils withstand grazing better than those on the Vernon soils. The Vernon soils will not support tall grasses under intensive grazing; therefore, short and mid grasses are dominant on those soils. Although the Vernon soils are probably best suited to short and mid grasses, some little bluestem grows on the areas that have a surface layer of loam or clay loam. The grasses on this complex respond to rainfall in summer, but they are dormant during extended dry periods. Proper management for these soils is described in the section "Range Management." (Capability unit VIe-3; Loamy Prairie and Red Clay Prairie range sites.)

Miller Series

The Miller series consists of reddish, calcareous soils of the bottom lands. The soils developed in weathered, reddish, calcareous clays and silts that were washed from areas of Foard, Tillman, and Vernon soils in the surrounding subhumid uplands. The uplands are underlain by Permian red beds. The Miller soils are on the flood plains of Deep Red Run Creek in the southwestern part of the county, and they also occupy small areas on the bottom lands along Beaver Creek.

The surface layer of these soils is 12 to 24 inches of reddish-brown clay. The clay is crumbly and friable when moist, but sticky and plastic when wet. It has a moderate, fine, blocky structure, and upon drying, it separates into small, hard blocks. The subsoil is clay. Below a depth of 30 inches, the soil material is more reddish than that in the upper part of the profile. It extends downward to the red clay parent material, which is below a depth of 40 to 50 inches. In places the parent material extends to a depth of many feet.

These soils occur with the Port, Treadway, Yahola, and Lincoln soils. They are more reddish and are more calcareous throughout than the Port soils, and they contain more clay. They resemble the Treadway soils, but they are higher in content of organic matter, more fertile, more porous, and more permeable than those soils. In addition, their structure is better developed than that of the Treadway soils. The Miller soils have a clayey subsoil and substratum, rather than a sandy subsoil and substratum like those of the Yahola and Lincoln soils.

The Miller soils are moderately well drained. They absorb water slowly, but they have a high water-holding capacity. Permeability is very slow. These soils are subject to occasional flooding, but damaging floods are not frequent. They are moderately fertile. The surface layer is mildly alkaline, and the subsoil and substratum are moderately alkaline. Free lime is normally at the surface and throughout the profile.

Good yields of wheat, oats, sorghum, and cotton are obtained on these soils. The areas that have good surface drainage are suited to alfalfa. The soils are also well suited to the plants that grow in native pastures. The main plants in the native pastures are switchgrass, Indiangrass, buffalograss, and big and little bluestem.

Miller clay (Mr).—This is the only Miller soil mapped in the county. The most important requirement in managing this soil is maintaining the supply of plant nutrients and favorable soil structure. The soil is suited to nearly all the crops commonly grown in the county. Its surface, however, tends to bake and crust. Therefore, the soil must

be managed carefully so that seeds will germinate properly and a good stand of seedlings will be obtained.

For best results from irrigation, this soil should be leveled. Most crops grown on it respond well to applications of fertilizer. Larger amounts of fertilizer should be applied if the soil is irrigated than if crops are grown without irrigation. (Capability unit IIIs–2; Heavy Bottom Land range site.)

Port Series

The Port series consists of dark-brown soils that developed in sediments of loam and clay loam. The sediments were washed from prairie uplands and were deposited over a long period of time. The vegetation under which the soils developed was an open forest of mixed hardwoods with an understory of tall grasses. These soils are on the nearly level flood plains of Cache, West Cache, and Beaver Creeks and on the bottom lands of other creeks in the county.

The surface layer of these soils is dominantly clay loam, but in some places it is loam or ranges to silt loam. Where the texture is clay loam, the surface layer is 2 to 3 feet thick and is generally dark brown, is friable or firm, and has medium, granular structure. Below a depth of 24 to 36 inches is reddish-brown soil material that in places extends downward to a depth of many feet. In some places the profile below the surface layer is highly stratified and contains thin layers of loam and silt loam.

Where the surface layer is loam, its color is dark brown to reddish brown. In most places the loam surface layer is 3 to 4 feet thick, but clay loam is at a depth of 18 to 20 inches in some places.

Where the texture of the surface layer ranges to silt loam, the surface layer is only 10 to 12 inches thick. At various depths there is a dark-brown layer, which is the surface layer of an old, buried soil.

Some areas of Port soils receive sediments from the clayey uplands. Deep in the profile in a few such areas, there is a band of silty clay loam that is slowly permeable. Water accumulates on the surface of these more clayey soils and soaks in to moisten the soil material to a considerable depth. Then, it is stored in the band of silty clay loam so that plants have enough moisture, even in dry seasons.

The more loamy Port soil is easier to work and is more permeable than the clay loam, but its subsoil stores less moisture for plants. The loamy soil is easier to work into a good seedbed for the crops that are commonly grown than the more clayey one. That is because it is at a slightly higher elevation and dries out faster.

In general, the Port soils are moderately fertile. They have good tilth and good structure. They are moderately permeable and have a moderate to high water-holding capacity. The surface layer is neutral, the subsoil is mildly alkaline, and the substratum is moderately alkaline. Free lime is normally at a depth of 20 to 30 inches.

These are among the most productive soils of the bottom lands in the county. Good yields are obtained on areas used to grow wheat, oats, cotton, sorghum, and alfalfa. The soils are well suited to pecan trees and to the plants in tame and native pastures. The plants in the tame pastures are mainly blue panic, King Ranch bluestem, and bermudagrass. Those in the native pastures are Indiangrass, switchgrass, and big and little bluestem.

Port clay loam (Po).—The main requirement in managing this soil is to maintain the supply of plant nutrients. This soil is suited to all the crops commonly grown in the county. It is well suited to irrigation, but it should be leveled for flood irrigation. (Capability unit I–2; Loamy Bottom Land range site.)

Port loam (Pr).—This soil is less extensive than Port clay loam. Most of the acreage is cultivated, and part of it is irrigated. This soil is suited to all the crops commonly grown in the county. Most crops grown on it respond to applications of fertilizer. The kinds and amounts of fertilizer to use should be indicated by testing the soil. Cover crops grown in winter will increase the fertility and improve the structure of this soil. (Capability unit I–2; Loamy Bottom Land range site.)

Port-slickspot complex (Ps).—This complex consists of areas in which Port loam, Port clay loam, and a slickspot soil are so intricately mixed that it is impractical to show them separately on a map. The Port soils make up 40 to 70 percent of the complex; the slickspot soil makes up 10 to 30 percent; and other soils that lie between the areas of Port soils and the slickspot soil make up 20 to 30 percent. The soils of this complex are on the flood plains of creeks throughout the county.

Of the Port soils in this complex, the clay loam is more extensive than the loam. The slickspot soil is similar to that described in complexes with the Foard soil, but it is on bottom lands rather than uplands. Its substratum is varied.

The soils of this complex are subject to flooding. In places where flooding is frequent, scour channels have formed. Such channels are generally intermittent and have only sparse vegetation. In many places alkali sacaton grows in clumps on scour channels that are otherwise bare. Flooding generally does not damage the native grasses, because the floodwaters usually do not remain on the areas for a long time.

The soils of this complex are not suited to cultivated crops; they are probably best suited to pastures consisting of native grasses. The Port soils are well suited to native tall and mid grasses, such as big and little bluestem, Indiangrass, and switchgrass, and they are well suited to bermudagrass. The slickspot soil is probably best suited to short and mid grasses, but little or no vegetation grows on some of the areas. The main plants in native pastures on areas of the slickspot soil are alkali sacaton, inland saltgrass, white tridens, and buffalograss (fig. 11). (Capability unit Vs–1; Loamy Bottom Land and Alkali Bottom Land range sites.)

Pratt Series

The Pratt series consists of brown, sandy soils of the uplands or high terraces. The soils developed in material blown from the channel of the Red River. They occupy areas that are as much as 1 mile wide and are parallel to the river. The topography in these areas is irregular and is billowy to duny. The slope ranges from 2 to 10 percent.

The surface layer, in an area that is gently sloping, is about 20 inches of brown to dark-brown, very friable loamy fine sand that has weak, granular structure. The soil material in the surface layer grades to that in the

subsoil. The subsoil is a lighter brown than the surface layer and consists of loamy fine sand that takes in water rapidly. The parent material is clay from the red beds and is at a depth of 8 to 12 feet or more.

***Figure 11.*—An area of Port-slickspot complex in native pasture. The main plants on areas of the slickspot soil are alkali sacaton, saltgrass, and buffalograss, but little or no vegetation grows on some of the areas. The Port soils are suited to native tall and mid grasses, such as bluestem, Indiangrass, and switchgrass.**

These soils occur with the Enterprise and Tivoli soils. They are coarser textured than the Enterprise soils, and they occupy areas closer to the river. The Pratt soils have a somewhat finer texture than the Tivoli soils, and they generally are in areas farther from the channel of the river.

The Pratt soils are somewhat excessively drained. They absorb water readily, but they have a moderate to low water-holding capacity. Permeability is moderately rapid. The soils are subject to severe wind erosion, but cover crops and crop residues on the surface will help to protect them.

These soils are used for crops, but they are only moderately productive of the crops that are commonly grown. They are well suited to native pasture, and under good management, moderate yields of forage can be expected. The main plants in the native pastures are sand bluestem, sand lovegrass, switchgrass, Indiangrass, and big and little bluestem.

Pratt loamy fine sand, undulating (PtB).—The main requirements in managing this soil are maintaining the supply of plant nutrients, maintaining the soil structure, and protecting the soil from erosion by wind. The soil is suited to cotton, sorghum, rye, vetch, and Austrian winter peas, but yields are only moderate. (Capability unit IIIe-4; Deep Sand range site.)

Pratt and Tivoli soils, rolling (PvC).—This mapping unit consists of Pratt loamy fine sand, Tivoli loamy fine sand, and Tivoli fine sand. The areas are so intermingled that it is impractical to show them separately on a map. The Pratt soils have a profile like that described for the series, but they are hummocky to rolling and have dunes as high as 25 feet.

The Tivoli soils have horizons that show little difference in texture but that differ in color. Their surface layer is brown and their subsoil is reddish yellow. The parent material is also reddish yellow to a depth of several feet. The surface layer is slightly darker than the subsoil and parent material because it has been stained by organic matter from plant residues that have decayed. The Tivoli soils are undulating to duny.

The soils in this mapping unit are not suited to cultivated crops; they are probably best suited to grazing. The native plants are little bluestem, big bluestem, sand bluestem, switchgrass, and Indiangrass. There is also some yucca, sand sage, and sandplum (fig. 12). (Capability unit VIe-2; Deep Sand range site.)

***Figure 12.*—A typical area of Pratt and Tivoli soils, rolling, showing the topography and native vegetation. These soils are subject to severe erosion by wind if they are not protected by a cover of native vegetation.**

Rough Broken Land

Rough broken land consists of hilly and broken escarpments in the uplands where severe geologic erosion has cut into the red clay beds and shales of Permian age. On the surface there are a few to many rocks, which range in size from fragments that are small to stones the size of boulders. This miscellaneous land type consists mainly of areas where there is little soil material and the parent material is at the surface. Little or no soil development has taken place.

Rough broken land (Rg).—This mapping unit consists of areas of Rough broken land that are generally 10 acres or more in size. Areas of less than 10 acres are normally mapped with the Vernon soils.

This miscellaneous land type occupies breaks and steep slopes for the most part. However, some eroded, less sloping areas of unconsolidated red clays and shales are included.

This land type is not suited to cultivated crops. It supports only a sparse amount of vegetation, and it has low value for grazing. The dominant vegetation consists of thin, scattered stands of side-oats grama, cactus, and a few mesquite trees (fig. 13). (Capability unit VIIs-1; Breaks range site.)

Shellabarger Series

The Shellabarger series consists of soils that occupy small areas on the flood plains along West Cache Creek. The soils are in areas where former meanders caused the streams to deposit coarse materials.

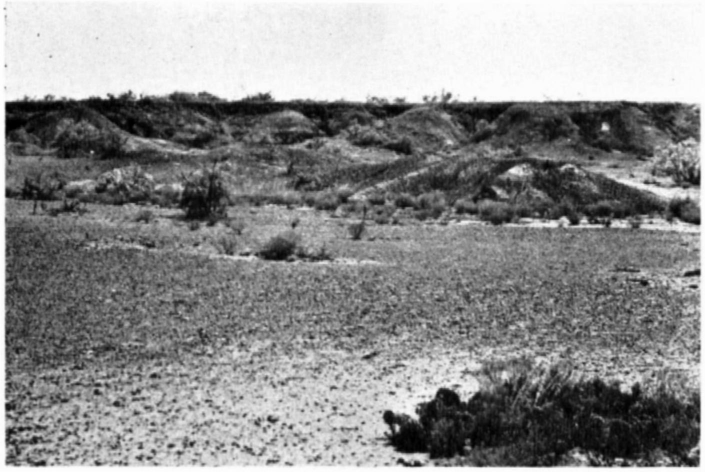

Figure 13.—**An area of Rough broken land showing the effects of geologic erosion and the sparse cover of vegetation. The plants growing here are side-oats grama, cactus, and mesquite trees.**

The surface layer of these soils, in an area that is smooth and gently sloping, is 10 to 20 inches of grayish-brown to dark grayish-brown, loose loamy sand that is structureless. The subsoil is friable, light sandy clay loam that is yellowish brown to reddish brown and has weak to moderate, blocky structure. The parent material is yellowish-red, noncalcareous granitic outwash. It is heavy loamy sand or light sandy clay loam and is at a depth of 60 inches or more.

These soils occur with the Lawton and Pratt soils. In some places on broad flood plains they are surrounded by Port soils. Their surface layer contains less loam than that of the Lawton soils, and their subsoil contains less clay. The Shellabarger soils are less strongly undulating than the Pratt soils, and they have various textures in the profile rather than having the same texture throughout.

The Shellabarger soils are well drained. They are slightly acid to neutral throughout.

Only fair yields of cotton, sorghum, and some small grains are obtained on these soils. The soils are probably best suited to native tall grasses. Switchgrass, Indiangrass, and big and little bluestem are suitable grasses to grow.

Shellabarger loamy sand, 0 to 4 percent slopes (ShB).—This is the only Shellabarger soil mapped in the county. It absorbs water readily, but it is low in organic matter. It is easy to work but is subject to severe erosion by wind. Most of this soil is cultivated, but some areas, once cultivated, have been seeded to native grasses. (Capability unit IIIe-4; Deep Sand range site.)

Tillman Series

The Tillman series consists of deep, reddish-brown to dark reddish-brown soils of the uplands. The soils are nearly level to gently sloping and developed in calcareous, red clay and shale from the Permian red beds. They occur throughout the county.

The surface layer is 6 to 12 inches of reddish-brown to dark reddish-brown, friable silt loam that has medium, granular structure. In most places, below the surface layer, there is 2 to 4 inches of dark reddish-brown, light clay loam that has a moderate, medium, granular structure. Below this layer is the subsoil of reddish-brown, compact, blocky clay. The subsoil is more reddish below a depth of 18 to 26 inches than it is in the upper part of the profile, and it merges indistinctly with the beds of clay that are at a depth of 5 to 8 feet. On the uplands south and southwest of Walters, the surface layer is slightly thicker than in other areas because a thin layer of loam has been deposited on these soils by wind and water. Some of the loam is believed to have been deposited by the floodwaters of streams during periods of high rainfall.

These soils occur with the Foard and Lawton soils. Also, in the northeastern part of the county, they are generally adjacent to the Zaneis soils. The gently sloping areas occur with the Vernon soils. The Tillman soils are similar to the Foard soils, but they generally have stronger slopes and a surface layer and subsoil that are more reddish. In addition, the boundary between the surface layer and the subsoil is gradual rather than abrupt like that between the surface layer and subsoil of the Foard soils. The Tillman soils have a subsoil of compact, heavy clay that is lacking in the Lawton and Zaneis soils, and their surface layer is less loamy. Their surface layer contains less clay than that of the Vernon soils, and they have a better developed subsoil. Also, the boundary between the subsoil and parent material is gradual rather than abrupt like that between the subsoil and parent material of the Vernon soils.

The Tillman soils are well drained. The movement of water through the lower part of the subsoil is very slow, and a large part of the water from rainfall is lost during all but the most gentle rains. In areas where the surface layer has good tilth, the 8 to 16 inches of granular soil material in the surface layer and the upper part of the subsoil absorbs water readily when the soil is dry. However, after field capacity has been reached, the rate of infiltration is very slow. The surface layer is slightly acid or neutral, the subsoil is neutral or mildly alkaline, and the substratum is moderately alkaline. Free lime is normally at a depth of 12 inches or more.

The Tillman soils are productive in years that have a fairly large amount of rainfall, but they are not suited to crops grown in summer. They are probably best suited to wheat, oats, barley, winter legumes, and other crops grown in cool seasons. Cotton and sorghum are not widely grown, because the summers are hot and dry and the moisture in the subsoil is not readily available to growing crops. The main plants in the native pastures are buffalograss, blue grama, and side-oats grama. Little bluestem grows in areas that have not been severely overgrazed.

Tillman silt loam, 1 to 3 percent slopes (TaB).—This is the only Tillman soil mapped in the county. It is one of the best soils for agriculture in the uplands. Its tilth is easy to maintain, and the soil contains a large amount of organic matter. The capacity of this soil to store water that plants can use is moderate to high. Most of the acreage is cultivated. This soil is suited to nearly all the crops commonly grown in the county.

Mapped with this soil are a few areas of a slickspot soil. The surface layer of this slickspot soil tends to form a hard crust, which causes the amount of runoff to be increased from these areas. The runoff has caused sheet erosion, which has made the surface layer of the slickspot

soil thinner than that of the Tillman soil. Also, clay from the subsoil has been mixed with the material from the surface layer, though in most places the clay subsoil is not within reach of tillage implements. Gully erosion is not a problem on the slickspot soil, except on the steeper slopes; there, the clay subsoil tends to resist downcutting. The included areas are too small to be mapped separately. (Capability unit IIIe–2; Hardland range site.)

Tipton Series

The Tipton series consists of brown to dark-brown, loamy soils of the uplands. The soils developed in loamy and silty alluvial material or in material that has been reworked by wind. They are nearly level to gently sloping and occur in broad bands that resemble terraces. The bands are parallel to the flood plains of the Red River.

The surface layer, in an area that is nearly level, is 10 to 18 inches of brown, friable loam that has granular structure. The material in the surface layer grades to a layer of dark-brown heavy loam that has a granular structure and extends downward to a depth of 20 to 24 inches. Below that layer is the subsoil of brown, firm light clay loam, which has moderate, subangular blocky structure. The parent material is yellowish red and is at a depth of 40 to 50 inches. In places it extends downward to a depth of several feet.

In places the dark-colored surface layer of an old, buried soil is at a depth of 50 to 60 inches. This buried soil is much older than the layers above.

The Tipton soils occur with the Enterprise and Foard soils. Their surface layer contains more loam and less sand that that of the Enterprise soils, which generally have the same texture throughout. The Tipton soils have a surface layer that contains less silt than that of the Foard soils and a subsoil that contains less clay. The Tipton soils occupy areas between the Enterprise soils, which are on the side nearest the river, and the Foard soils, which are on the side farthest from the river.

The Tipton soils are well drained. They absorb water readily and store moderate amounts of it in their subsoil for plants to use. Permeability is moderate, and the soils are easy to work. The risk of wind erosion is slight on these soils, but there is a moderate risk of water erosion on the more sloping areas. The surface layer is neutral, the subsoil is mildly alkaline, and the substratum is moderately to strongly alkaline. Free lime is normally at a depth of 30 to 50 inches.

The Tipton soils are among the most productive soils in the county. Good yields of wheat, oats, barley, cotton, and sorghum are obtained from crops grown on them. Most of the acreage is cultivated, but a small part is in native grasses. The soils are suited to alfalfa, although that crop is not grown extensively, and they are also well suited to the plants grown in pastures. Summer crops grow well on these soils when rainfall is plentiful. The main plants in the native pastures are big and little bluestem, switchgrass, and Indiangrass. Bermudagrass, blue panic, and King Ranch bluestem are suitable plants to grow in the tame pastures.

Tipton loam, 0 to 1 percent slopes (TpA).—This soil is well suited to irrigation, and some of it is irrigated. Most of the areas need to be leveled if the flood-irrigation system is used. Sprinkler irrigation can be used without special preparation of the site. A larger amount of fertilizer can be used on the areas that are irrigated than on other areas.

Crops grown on this soil respond well if they are tilled properly and if proper kinds and amounts of fertilizer are added. Good yields are obtained of all the crops commonly grown in the county. The main requirement in managing this soil is maintaining the supply of plant nutrients. The kinds and amounts of fertilizer to use should be determined by soil tests. (Capability unit I–2; Loamy Prairie range site.)

Tipton loam, 1 to 3 percent slopes (TpB).—This gently sloping soil is adjacent to areas of Tipton loam, 0 to 1 percent slopes. It also grades to the Enterprise very fine sandy loams in many places and is bordered by the Foard soils on the opposite side.

This soil contains a large amount of organic matter, and it has good tilth that is easy to maintain. Cultivating on the contour helps conserve moisture. Stubble-mulch tillage also conserves moisture and helps improve the structure of the soil. These practices reduce runoff, and help to prevent erosion. Terraces are used to divert runoff to well-protected waterways, and they also serve as guidelines for contour farming.

Cover crops, such as vetch or Austrian winter peas grown with a small grain, generally do well on this soil. They can be harvested for seed in most years or plowed under as green manure before the summer crop is planted. The crops respond well if they are properly tilled and if the proper kinds and amounts of fertilizer are added. Nitrogen and phosphate are needed for the best yields of most crops. (Capability unit IIe-1; Loamy Prairie range site.)

Tivoli Series

The Tivoli series consists of light-colored, loose, sandy soils that are undulating to duny. These soils have a brown surface layer and a reddish-yellow subsoil. Their subsoil is more sandy than those of the associated Pratt and Enterprise soils.

In this county the Tivoli soils are mapped only in an undifferentiated mapping unit with Pratt soils. A description of Pratt and Tivoli soils is found under the Pratt series.

Treadway Series

The Treadway series consists of reddish-brown to red, unweathered, compact, clayey alluvium that is mostly calcareous. The soils have developed in alluvium on fans or aprons and on flats and flood plains. They lie below steep breaks of the Vernon soils and below areas of Rough broken land where there are outcrops of clay and shale from the red beds.

Generally, the clayey alluvium forms a hard crust on the surface of these soils. The soil material in the crust has a weak, platy structure. It overlies 8 to 10 inches of reddish, heavy clay or clay loam that is massive, or structureless, and is almost impervious to water, air, and roots. Below the clay or clay loam is unconsolidated or shaly clay that extends to a depth of 50 inches or more. The color of this unconsolidated or shaly clay is generally reddish brown, but in places it ranges to yellowish red.

In some areas of these soils near the Red River, a loamy mantle, 6 to 12 inches thick, makes up the surface layer. The soil material in this mantle consists of sands and silts blown from the flood plains of the river. It stores little moisture for plants. The principal vegetation on the Treadway soils is a sparse to moderate cover of native short grasses, cactus, and mesquite.

These Treadway soils occur with the Tillman, Vernon, Miller, and Port soils. They are similar to the Miller soils in color, texture, and reaction; but they are different from all the associated soils because they are unconsolidated, droughty, low in fertility, and low in content of organic matter. Unlike the associated soils, the Treadway soils have sparse vegetation, little soil structure, very low porosity and permeability, and a hard crust on the surface.

The surface layer of the Treadway soils is mildly or moderately alkaline, and their substratum is moderately alkaline. Free lime is normally at the surface and throughout the profile.

Some attempts have been made to cultivate these soils, but the soils are unsuited to cultivated crops. Most of the acreage is in native pasture or range, although little forage is produced.

Treadway soils (Ts).—The Treadway soils in this county are mapped as one unit. The soils are gently sloping and occur in scattered areas, mainly in the southwestern part of the county. Only small amounts of forage are obtained from the native pastures on these soils. The plants in the native pastures are buffalograss, blue grama, and side-oats grama. The management of these soils is discussed in the section "Range Management." (Capability unit VIs-1; Red Clay Flats range site.)

Vernon Series

The Vernon series consists of reddish-brown, calcareous, compact, clayey soils of the uplands. The soils developed under native grass in clays of the Permian red beds. They are gently sloping to steep and are on the rolling prairie areas throughout the county. Vernon clays are dominant in the gently sloping areas, and Vernon clay loams are dominant in the steeply sloping areas.

The surface layer, in an area where slopes are 1 to 2 percent, is generally 6 to 10 inches of reddish-brown to dark reddish-brown, firm clay that has weak, fine, blocky structure. Below the surface layer is red, compact clay, which is sticky and plastic when wet. The clay breaks to very hard, intractable clods when dry, and these clods have slick and glistening surfaces when moist. White spots, or concretions of carbonate of lime, are common below a depth of 6 to 8 inches. In places the clay is compacted and has formed weak layers of shale.

In areas near the Red River, the surface layer consists of 6 to 12 inches of loamy material. It is composed of sands, silts, and clays that were blown from the channel of the river.

The Vernon soils occur with the Tillman, Lawton, and Treadway soils. They are shallower over bedrock than the Tillman soils. In addition, their profile is less well developed, they have free lime in the surface layer, and they lack the claypan in the subsoil that is common in the Tillman soils. The Vernon soils are calcareous and are more clayey throughout than the Lawton soils. Their parent material is clay from the red beds rather than alluvium like that of the Treadway soils. In addition, they have a weak structure rather than being structureless.

The Vernon soils have a moderately alkaline surface layer and substratum. Free lime is generally at the surface and throughout the profile.

The gently to moderately sloping soils, which are deeper and smoother than the steeply sloping soils, are used for cultivated crops. The areas that are steeper and shallower over clay and that have occasional outcrops of rock are used for grazing. The main plants in the native pastures and range areas are side-oats grama, blue grama, and buffalograss. On the areas that have a loamy surface layer, there is some growth of little bluestem.

Vernon clay, 1 to 3 percent slopes (VcB).—This soil is generally on broad ridgetops, but in places it is on foot slopes below the steeper areas of Vernon soils.

The main requirements in managing this soil are maintaining the supply of plant nutrients and favorable soil structure and protecting the soil from erosion. Much of the acreage is cultivated, and fair yields of wheat and sorghum are obtained.

This soil is not well suited to crops other than wheat and sorghum, because of the layer of compact clay near the surface, the large amount of runoff, and the lack of moisture in the profile. Some of the areas are in pastures of native grasses. The main plants in these pastures are buffalograss, blue grama, and side-oats grama. (Capability unit IIIe-3; Red Clay Prairie range site.)

Vernon soils, 3 to 5 percent slopes (VsC).—These soils have a profile like the one described for the series, except that in most areas the surface layer is clay loam. The soils are generally on side slopes above natural drains, but in places they are below the broad ridgetops occupied by Vernon clay, 1 to 3 percent slopes.

If these soils are used for cultivated crops, the principal management requirements are to conserve moisture and to protect the soils from erosion. Much of the acreage is cultivated, and fair yields of wheat and sorghum are obtained. Some areas are in native pasture or range. (Capability unit IVe-2; Red Clay Prairie range site.)

Vernon soils, 5 to 12 percent slopes (VsE).—In these soils unconsolidated clay and shale is nearer the surface than it is in the profile described for the series. These soils generally have scattered rocks or pebbles on the surface. In addition, the surface layer in most areas is clay loam.

These soils are used for pasture or range and are not suited to cultivated crops. The vegetation is mainly short, mid, and tall grasses. The tall grasses grow in areas where the surface layer is clay loam. In places a sparse to thick cover of mesquite trees grows on the soils. Several methods, such as pouring kerosene on the crowns, have been used to kill the mesquite trees. Other management practices are discussed in the section "Range Management." (Capability unit VIe-4; Red Clay Prairie range site.)

Waurika Series

The Waurika series consists of grayish-brown, nearly level to slightly concave soils of the uplands. The soils

developed in thick clay from red beds of Permian age. They are in the east-central part of the county.

The surface layer of these soils is 10 to 14 inches of friable silt loam that is grayish brown in the upper part and has a weak, granular structure. The lower 2 to 5 inches of the surface layer is light gray. An abrupt boundary separates the surface layer and the subsoil. The subsoil is dark grayish-brown, very firm clay (claypan), and it has fine to medium, blocky structure. Below a depth of 26 to 32 inches, the color of the soil material grades to grayish brown or reddish brown like that of the clayey parent material. The parent material is below a depth of 4 to 5 feet. In many places it is mottled with yellowish red where there are patches of clay loam. Only slightly altered clays from the red beds are at a depth of 5 to 8 feet below the surface.

These soils occur with the Foard soils. They are somewhat similar to those soils, but they have a distinct, whitish or grayish layer that rests abruptly on the compact claypan.

The Waurika soils are moderately well drained. In areas where the surface layer has good tilth, the first ½ to 1 inch of rainfall penetrates the soil readily and saturates the layers above the claypan. Water moves very slowly through the claypan. A few spots remain wet for a long time after a heavy rain, and some water is held in shallow, circular depressions until it evaporates. The amount of available moisture is often insufficient, however, for crops grown in summer. The surface layer is slightly acid or neutral, the subsoil is neutral or mildly alkaline, and the substratum is mildly or moderately alkaline. Free lime is generally at a depth of 30 inches or more.

Erosion is not a problem on these soils. All practical methods are needed, however, to increase the amount of water that soaks in so as to utilize the large storage capacity of this soil. Crop residues should be plowed under to keep the soil porous and to help prevent the surface from crusting and sealing. Sloping areas should be cultivated on the contour. Growing two crops on this soil in the same year is seldom, if ever, a good practice.

The Waurika soils are only moderately productive. Moderate yields of wheat, oats, and sorghum are obtained, and cotton makes moderate yields in years of ample rainfall. The soils are suited to tame and native pastures. The main plants in the native pastures are buffalograss, side-oats grama, and blue grama.

Waurika silt loam (Wa).—This is the only Waurika soil mapped in the county. Most of it is cultivated, but a few areas are in pastures of native short grasses. The main requirements are maintaining the supply of plant nutrients, maintaining soil structure, and preventing crusting. Most crops grown on this soil respond if fertilizer is applied in amounts indicated by testing the soils. (Capability unit IIs-1; Hardland range site.)

Yahola Series

The Yahola series consists of soils on the flood plains of the Red River. The soils are flooded occasionally, but the floodwaters do not remain long.

In most places the surface layer of these soils is 18 to 24 inches of brown to reddish-brown, friable, mildly calcareous fine sandy loam, but there are small pockets where the texture is clay or clay loam. The soil material in the surface layer grades to that in the subsoil. The subsoil is light reddish brown or yellowish red and is stratified loamy fine sand and silt loam. There are occasional bands of clay loam in the substratum.

These soils occur with the Lincoln and Miller soils. They are more reddish and more loamy than the Lincoln soils, and they are at slightly higher elevations. Their surface layer and subsoil are more sandy throughout than those of the Miller soils.

The Yahola soils absorb water readily, but they store only moderate amounts of water in their subsoil. Permeability is moderate, and the occasional floods add plant nutrients. There is a hazard of erosion by wind, but it is only slight if the soils are protected by cover crops and crop residues. The surface layer is neutral or mildly alkaline, depending on the frequency of overflow and on the source and thickness of new sediments. The lower part of the subsoil and the substratum are strongly calcareous to moderately alkaline. These soils are easy to work.

These soils are among the most productive in the county. Good yields of alfalfa, small grains, cotton, sorghum, and other commonly grown crops are obtained on them, but the yields can be improved. The soils are suited to corn, but that crop is not grown extensively. They are also well suited to alfalfa grown in rotation with other crops. If the row crops do not follow legumes, most of them respond if nitrogen and phosphate are added. Alfalfa can generally be started without fertilizer, but normally a topdressing of phosphate is needed to maintain good yields and to prolong the life of the stand.

Yahola fine sandy loam (Ya).—This is the only Yahola soil mapped in the county. It is in areas that are nearly level to slightly wavy and is on the flood plains of the Red River. Its profile is like the one described for the Yahola series.

In many places areas of this soil contain pockets of long, narrow swales where the texture of the surface layer is clay loam. These areas are generally only a few feet wide and have little effect on the use and management of the soil. They are likely to remain moist longer after rains, however, than the other areas of this soil, and, as a result, tillage may be delayed somewhat. Surface drainage ranges from good to poor in this soil, but internal drainage is adequate for good growth of crops.

Yields of small grains, cotton, alfalfa, and truck crops grown on this soil are generally good, but they can be improved. Managing the soil well, irrigating it, and applying the proper kinds and amounts of fertilizer will improve the yields. The crops in irrigated areas will need larger quantities of fertilizer than those in areas not irrigated. (Capability unit IIw-1; Loamy Bottom Land range site.)

Zaneis Series

The Zaneis series consists of reddish-brown soils of the uplands. The soils developed under tall grasses in alkaline to calcareous clays and clay loams of the red beds. The clays and clay loams are interbedded with layers of sandstone and siltstone (fig. 14). The soils are on the rolling hills that border the streams in the eastern one-half of the county. Their slope ranges from 1 to 5 percent.

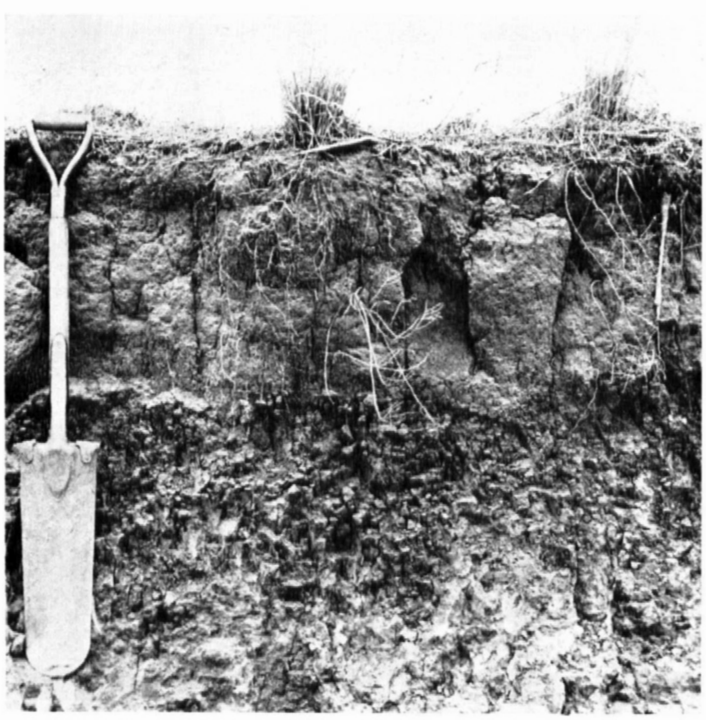

Figure 14.—**An area of Zaneis loam where sandstone and siltstone are interbedded with the clay loam. In places grass roots have penetrated the subsoil.**

The surface layer of these soils, in an area that is gently sloping, is 7 to 12 inches of reddish-brown or dark reddish-brown, friable loam that has weak, granular structure. The material in the surface layer grades to red or dark-red, friable light clay loam that extends downward to a depth of 12 to 15 inches. The soil material below the light clay loam is reddish-brown or dark reddish-brown, friable or firm silty clay loam that is slowly permeable. Below a depth of 30 inches, the substratum, which is more reddish than the layers above, grades to red clay loam. In most places, below a depth of 40 to 50 inches, there are seams of weathered, fine-grained sandstone and siltstone in the red clay loam. In some places these seams extend downward for several feet.

These soils occur with the Chickasha, Tillman, and Waurika soils. They are more reddish than the Chickasha soils and are less sandy and more alkaline. The Zaneis soils lack the subsoil of compact, blocky clay that is common in the Tillman soils, and they are more sloping than the Waurika soils. They also lack the claypan, or subsoil of blocky clay and the well-developed, leached or gray layer that overlies the subsoil, which are characteristic of the Waurika soils.

The Zaneis soils absorb water readily and have a moderate capacity to hold water that plants can use. Permeability is slow. The surface layer is slightly acid or neutral, the subsoil is neutral or mildly alkaline, and the substratum is mildly or moderately alkaline. Free lime is generally at a depth of 40 to 60 inches.

These soils are easy to work, but there is a large amount of runoff, and erosion is a hazard on the sloping areas. Gullies form easily in this soil because the subsoil erodes readily. A large acreage where erosion has been active and gullies have formed is no longer useful for crops. Many of the eroded areas have been seeded to native grasses, but many eroded fields have been terraced and are now tilled on the contour. Low spots in some of the terrace channels hold water and delay cultivation and harvesting. Continued tillage gradually fills these spots, and the terraced fields will improve with use.

The Zaneis soils are among the most productive of the soils of the uplands. They are used to grow wheat, oats, cotton, and sorghum, and good yields are obtained. The soils are suited to alfalfa, but that crop is not grown extensively, because the summers are too hot and dry. Row crops and small grains respond well to applications of nitrogen and phosphate. The amount of fertilizer used should be adjusted whenever the moisture stored in the subsoil varies from the amount that is normal for the time of application. The pastures in native tall grasses yield only fair amounts of forage, and they contain many undesirable grasses and weeds. Tall grasses grow well on these soils if grazing is reasonably well managed. Trampling and close grazing reduce the ability of the soils to absorb water. As the subsoil becomes drier, the tall grasses thin out and are replaced by short, less productive grasses.

Zaneis loam, 1 to 3 percent slopes (ZaB).—Nearly all of this soil is cultivated, but a few areas are in native range and pasture. Wheat is the main crop. This soil is considered better than the Tillman soils for summer crops because rains in summer are more effective in adding moisture that plants can use. The pastures are commonly overgrazed and do not produce as much forage as they could under improved management.

Mapped with this soil are occasional areas where a slickspot soil occurs. Where such areas are extensive, they are mapped as a Zaneis-slickspot complex.

The hazard of erosion is not great on Zaneis loam, 1 to 3 percent slopes, but it is always a problem. Stubble mulching and cultivating on the contour will help to control erosion. Also, in some places terraces are needed to help protect the soil, and they conserve moisture for growing crops.

Small grains and row crops grown on this soil generally respond to fertilizer, and they need nitrogen and phosphate for the best yields. Alfalfa and sweetclover need phosphate for satisfactory growth. Nitrogen, applied when alfalfa and sweetclover are seeded, assures a better stand and more vigorous seedlings. (Capability unit IIe–2; Loamy Prairie range site.)

Zaneis loam, 3 to 5 percent slopes (ZaC).—This soil has a thinner surface layer than Zaneis loam, 1 to 3 percent slopes. Most of it is in pasture. In areas that are cultivated, however, more of the acreage is used for wheat, oats, and sorghum than for row crops.

The hazard of erosion is severe on the cultivated areas. The main requirements in managing the soil consist of protecting the areas from erosion and conserving moisture. Cultivating on the contour and using terraces to divert runoff to protected drainageways are effective methods for protecting the soil from erosion and for conserving moisture. The terraces also act as a guide for cultivating on the contour. Stubble mulching should be used to keep the soil porous so that water will soak in readily. A rotation of wheat and legumes provides effective cover and a mulch. (Capability unit IIIe–1; Loamy Prairie range site.)

Zaneis loam, 3 to 5 percent slopes, eroded (ZaC2).—All of this soil was once cultivated. The cultivated areas are eroded, and in many places the surface layer is much thinner than it was originally. Because of the thin surface layer and the low fertility, many areas of this soil are no longer used for crops. Some of the areas have been seeded to native grasses. Where rills and shallow gullies have been plowed over and smoothed, the only evidence of erosion is the color of the surface layer. If this soil is managed intensively, all of it is suited to cultivated crops.

Small grains grown on this soil need phosphate, and in favorable seasons nitrogen is required to increase yields. In years that have adequate rainfall, sorghum benefits from applications of a nitrogen fertilizer if the soil contains ample phosphate. (Capability unit IVe–4; Loamy Prairie range site.)

Zaneis soils, severely eroded (Zn3).—These soils are so eroded and gullied that they can no longer be used for crops. Some areas are below steep slopes and receive much harmful runoff. Other areas occur as rims around smooth areas of the Zaneis and Chickasha soils on flats, ridges, and divides.

These soils developed in less clayey red beds than the other Zaneis soils, but they contain some layers of heavy clay. In many places the clay is exposed in deep gullies and in eroded galls. The loamy surface layer of the soil between the gullies and galls, in some places, has been only slightly altered by erosion and is like that of Zaneis loam, 3 to 5 percent slopes. The thickness of the surface layer ranges from a thin film to as much as 12 inches. In some places all of the original surface layer has been removed by erosion.

Mapped with these soils are a few areas of Lucien soils, which are shallow over sandstone. Narrow areas of Noble soils, which occur on foot slopes and are not mapped separately in this county, are also included. The areas of Lucien and Noble soils are too small to be mapped separately.

The soils in this mapping unit are suited to native tall grasses, and some areas have been seeded. Bermudagrass grows well on these soils if it is fertilized properly. It must be managed carefully to produce large amounts of forage and to check erosion in the gullies and galled areas. The soil material in the gullies becomes stabilized more rapidly if runoff is diverted from the areas. (Capability unit VIe–3; Loamy Prairie range site.)

Zaneis-slickspot complex, 1 to 3 percent slopes (ZsB).—This complex consists of areas in which Zaneis loams and a slickspot soil are so intricately mixed that it is impractical to show them separately on a map. It also contains a soil that lies between areas of the Zaneis soils and the slickspot soil and has characteristics of both. From 30 to 60 percent of the acreage consists of Zaneis loams; from 10 to 35 percent, of a slickspot soil; and from 20 to 30 percent, of the soil that lies between areas of Zaneis soils and the slickspot soil. The complex occurs mainly in the eastern one-half of the county.

The slickspot soil in this complex is similar to the one described under Foard-slickspot complex, 0 to 1 percent slopes, but surface crusting is slightly less serious on this soil. The soil material in the substratum grades to red clay loam that is similar to the clay loam underlying the Zaneis soils. The soil between areas of the Zaneis soils and the slickspot soil has a surface layer similar to that of the Zaneis soils and a subsoil like that of the slickspot soil.

In areas that have been cultivated, there is a hazard of erosion. In many places the surface layer is thinner than the original one because it is eroded. In places, where all of the original surface layer has been lost through erosion, the areas of the slickspot soil are larger than in less eroded areas. There are some rills and gullies in the soils of this complex. Many of the eroded areas are no longer useful for crops, and some of them have been seeded to native grasses. The main plants in the native pastures on the Zaneis soils and on the soil that has characteristics of both the Zaneis soils and of the slickspot soil are little bluestem, big bluestem, Indiangrass, and switchgrass. Buffalograss, alkali sacaton, blue grama, and sideoats grama are suitable for the slickspot soil.

If the soils in this complex are cultivated, they need to be managed intensively to protect them from erosion, to reduce crusting of the surface layer, to increase the rate of moisture intake, and to help maintain their structure. Constructing diversion terraces, establishing perennial vegetation in drainageways, using a cropping system made up largely of close-growing plants, and using stubble-mulch tillage are some practices that are needed to help conserve moisture and to help protect the soil from erosion.

If the soils in this complex are managed intensively, fair yields of wheat, oats, and sorghum can be obtained on the areas of Zaneis loams; only poor yields can be expected on the slickspot soil. The Zaneis loams are suited to cotton, but that crop is not grown extensively. Small grains and row crops grown on the soils of this complex respond well to fertilizer if there is ample rainfall. (Capability unit IVe–3; Loamy Prairie and Slickspot range sites.)

Use and Management of Soils

This section first describes some basic practices of management for soils used for cultivated crops. Then the system of capability grouping is defined, and the use and management of the soils in each capability unit are discussed. Following this are estimated average yields of the principal dryland crops obtained under customary management and improved management, a discussion of irrigation, and, finally, the use and management of soils for range, woodland and windbreaks, wildlife, and engineering.

Basic Practices for Management [1]

In the following pages basic management practices farmers need to consider in planning the use of the soils in Cotton County are discussed. In this county the main problems in management are protecting the soils from erosion by wind and water, maintaining good tilth, and supplying plant nutrients in amounts adequate for an efficient, high level of production. The practices that help to achieve these objectives are keeping tillage to a minimum, growing cover crops, conserving crop residues,

[1] By M. D. Gamble, conservation agronomist, Soil Conservation Service.

applying fertilizer, using stripcropping, constructing terraces, farming on the contour, and keeping permanent vegetation in the waterways.

Cropping systems.—If a good cropping system is practiced, the soils remain productive year after year and crops make good yields at the least practical cost. Also, such a cropping system maintains or improves the tilth of the soils (fig. 15), helps to conserve moisture and control erosion, and aids in controlling weeds, insects, and diseases.

***Figure 15.*—Two samples of a soil showing the deterioration that takes place if the cropping system consists mainly of soil-depleting crops. The soil on the left has been used to grow soil-depleting crops year after year over a long period of time. The sample on the right was taken from an area where the soil had been kept under grass a large part of the time.**

Soil-improving crops—mainly legumes and grasses—need to be included in the cropping system. Among the most beneficial of the soil-building legumes is alfalfa. The last cutting of alfalfa ought to be plowed under at the end of the rotation. Rye and vetch can also be included in the cropping system as soil-improving crops. They will help to control erosion.

The soils and climate of Cotton County are suited to wheat, oats, rye, barley, sorghum, sudangrass, cotton, peanuts, and certain other crops. In years of above-normal rainfall, alfalfa grows well on the bottom lands and on nearly level uplands. The native grasses are an important source of forage during the warm seasons. In a long cropping system, they are also excellent for improving the soils.

Minimum tillage.—Use of minimum tillage is essential in this county. Of course, when the soils are used for crops, they must be worked to prepare a seedbed, to control weeds or other competitive vegetation, and to provide a favorable place for plants to grow. But tillage breaks down the structure of the soils. If tillage is excessive, it pulverizes the soil material, and the size of the natural aggregates is greatly reduced. The soils then tend to puddle and crust at the surface. As a result, they take in less water and air and store less moisture for plants. Excessive tillage is also costly.

Compaction is a problem in managing the soils of this county. When the soils are plowed year after year at the same depth, a dense, compact layer, or plowpan, forms, particularly in soils that have a surface layer of loam or silt loam. This pan, just below plow depth, reduces aeration and the ability of the soils to store moisture. The plowpan ordinarily restricts the normal growth of roots. In some instances, plants can use only the moisture and nutrients available above the pan, or to the depth of normal tillage.

Use of cover crops.—The sandy soils of this county are susceptible to erosion by wind and water in winter and early in spring. Therefore, cover crops are grown extensively to protect them. The practical experience of farmers in the county shows that the benefits from a cover crop, especially from those grown on sandy soils, more than offset the fact that the cover crop uses moisture needed for the crop that follows. Rye is the main cover crop grown in this county.

Growing rye or vetch as a cover crop generally increases the yields of other crops grown in the cropping sequence. By using a specially constructed drill, rye or some other small grain can be seeded in a row crop early in September.

Conservation of crop residues.—Leaving crop residues on the surface during periods when erosion is critical, or working them into the surface soil, are desirable practices on all the soils that do not require stubble mulching. These practices help to protect the soils from wind erosion and are usually needed in winter and early in spring. Crop residues contain a part of the nutrients the plants took from the soil when they were growing. When these residues are returned to the soil, micro-organisms break them down to humus, which restores to the soil some of the nutrients that were removed by the crop. Furthermore, the humus improves the structure of the surface layer and makes the surface layer more porous. As a result, surface crusting is reduced and infiltration is increased.

In years of normal or above-normal rainfall, when the straw from small grains is plowed under, nitrogen fertilizer should usually be added to help decompose the straw. During years when rainfall is limited, however, or when there is only a small amount of straw, nitrogen fertilizer is not needed. A nitrogen fertilizer improves yields if a large amount of straw has been turned under.

Stubble mulching (fig. 16) is a year-round system of farming designed to keep a protective cover of crop residues on the surface until the next crop is seeded. This system requires the use of sweeps, rod weeders, and blades

***Figure 16.*—Stubble mulching in a field used for wheat. Stubble mulching helps to protect the soil by keeping a cover of crop residues on the surface.**

that undercut the sod or stubble and leave residues on the surface. Some farmers practice stubble mulching by going over the fields where wheat has been harvested with a chisel or sweep to control weeds and prepare a seedbed. These implements leave protective amounts of stubble on the surface at seeding time. The seeding equipment must be capable of drilling through the trashy cover.

The amount of residue needed on the surface to control wind erosion depends on the speed of the prevailing winds, and on the kinds of soil and their tilth.

Use of fertilizer.—The soils on which fertilizer will benefit crops the most are those that are moderately sandy or sandy, especially if they are inherently low in fertility. The kinds and amounts of fertilizer to use should be based on recommendations of the Oklahoma Agricultural Experiment Station. Most of the soils in this county do not need lime, but some soils can be improved by treating them with agricultural gypsum.

Stripcropping.—Stripcropping helps to control wind erosion on sandy soils. It consists of growing different kinds of crops in alternate strips with small grains or other close-growing crops. If sorghum is grown in the strips, a high stubble is left to help provide protection from wind in winter and early in spring.

The width of the strips planted to row crops depends on the erodibility of the soils. Many factors affect erosion, but the amount of erosion depends especially on the texture of the soils. The strips of close-growing crops and of cultivated crops need to be of the same width. All strips should be as near to right angles to the direction of the prevailing winds as practicable.

Use of terraces.—A terrace is a combination of a ridge and channel built across the slope, generally at a slight grade. Terraces reduce erosion and help to conserve moisture; they also serve as guidelines for contour farming. The differences between a field terrace and a diversion terrace are mainly those of size and purpose. A field terrace is designed mainly to slow or stop the movement of water in a field. A diversion terrace is used to protect the soils in a cultivated field from runoff from adjoining land.

Field terraces, by increasing the amount of water that soaks in, appreciably improve crop yields where limited moisture is one of the chief obstacles to good yields. In this county a wide-based, channel-type terrace is suitable.

Contour farming.—Plowing, planting, and tilling soils as nearly at right angles to the slope as practicable (fig. 17), instead of up and down the slope, has many advantages. Erosion by water is reduced because more water soaks into the soil. In response, crops grow better because there is generally more available moisture. Farm equipment is easier and sometimes more economical to operate on the contour. Contour farming is a must if the land is terraced. It is also effective, however, on land that has not been terraced.

Use of grassed waterways.—Grassed waterways are used to carry off excess water from the soils without causing erosion (fig. 18). They are used with terrace systems, diversion terraces, drainage or irrigation systems, and natural drains.

Each waterway must be individually designed. The width and depth of the waterway and the kind of vegetation needed are determined primarily by the size of the area, the slope, the permeability of the soils, the practices used to control erosion, and the vegetative cover on the drainage area. Bermudagrass or native grasses are commonly used to provide a vegetative cover in the waterways.

Practices needed to maintain the waterways consist of (1) fencing, if practical, (2) mowing or spraying to control weeds, (3) lifting farm implements when crossing the waterway, (4) establishing farm roads in other areas so that the waterway will not be used as a road, (5) protecting the waterway from overgrazing, (6) fertilizing as needed, and (7) plowing carefully or performing other farming operations so that the waterway will not be crowded.

***Figure 17.*—A field where contour farming has been practiced. This practice helps to control erosion and holds back water so that it will soak into the soil rather than be lost through runoff.**

***Figure 18.*—A well-protected, shaped, grassed waterway that safely disposes of excess water that has accumulated behind terraces.**

Capability Groups of Soils

The capability classification is a grouping of soils that shows, in a general way, how suitable the soils are for most kinds of farming. It is a practical grouping based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment.

In this system all the kinds of soil are grouped at three levels, the capability class, subclass, and unit. The eight

capability classes in the broadest grouping are designated by Roman numerals I through VIII. In class I are the soils that have few limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products. None of the soils in Cotton County is in class VIII.

The subclasses indicate major kinds of limitations within the classes. Within most of the classes there can be as many as four subclasses. The subclass is indicated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* means that water in or on the soil will interfere with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the country, indicates that the chief limitation is a climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only subclasses *w*, *s*, and *c*, because the soils in it have little or no susceptibility to erosion but have other limitations that limit their use largely to pasture, range, woodland, or wildlife.

Within the subclasses are the capability units, groups of soils enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping of soils for making many statements about their management. Capability units are generally identified by numbers assigned locally, for example, IIe-1 or IIIe-2.

Soils are classified in capability classes, subclasses, and units in accordance with the degree and kind of their permanent limitations; but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soil; and without consideration of possible but unlikely major reclamation projects.

The soils in the county were assigned to capability units on a statewide basis. Since not all of the capability units in the State are represented in this county, the numbering of the units may not be consecutive. For example, no soils of capability unit IIw-3 are in Cotton County. Therefore, capability unit IIw-3 is not discussed in this report. The eight classes in the capability system, and the subclasses and units in this county, are described in the list that follows.

Class I. Soils that have few limitations that restrict their use.
- (No subclasses.)
  - Unit I-1: Deep, well-drained, nearly level soils of the uplands.
  - Unit I-2: Deep, well-drained, nearly level soils on bottom lands and on flats or benches of high stream terraces.

Class II. Soils that have some limitations that reduce the choice of plants or that require moderate conservation practices.
- Subclass IIe: Soils subject to moderate erosion if they are not protected.
  - Unit IIe-1: Deep, well-drained, gently sloping soils of the uplands and high stream terraces.
  - Unit IIe-2: Deep, well-drained, gently sloping soils that have a slowly permeable subsoil and are on uplands.
- Subclass IIw: Soils that have moderate limitations because of excess water.
  - Unit IIw-1: Deep, nearly level soil of flood plains and subject to occasional flooding.
- Subclass IIs: Soils that have moderate limitations of moisture capacity or tilth.
  - Unit IIs-1: Deep, nearly level soils that have a fine-textured subsoil and are on uplands.
- Subclass IIc: Soils that have slight limitations because of climate.
  - Unit IIc-1: Deep, friable, nearly level soil that has a moderately permeable subsoil and is on uplands or terrace benches.

Class III. Soils that have severe limitations that reduce the choice of plants, or require special conservation practices, or both.
- Subclass IIIe: Soils subject to severe erosion if they are cultivated and not protected.
  - Unit IIIe-1: Deep, moderately to slowly permeable, moderately sloping soils of the uplands.
  - Unit IIIe-2: Deep, gently sloping soils of the uplands that have a fine-textured subsoil.
  - Unit IIIe-3: Shallow to moderately deep, gently sloping soil of the uplands.
  - Unit IIIe-4: Sandy soils of the uplands, subject to severe wind erosion.
- Subclass IIIs: Soils that have severe limitations of moisture capacity or tilth.
  - Unit IIIs-1: Deep, nearly level, poorly drained soils of uplands that have few to numerous areas of a slickspot soil.
  - Unit IIIs-2: Deep, nearly level, poorly drained soil of the bottom lands.

Class IV. Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both.
- Subclass IVe: Soils subject to severe erosion if they are cultivated and not protected.
  - Unit IVe-1: Deep, moderately permeable, strongly sloping soil of the uplands.
  - Unit IVe-2: Shallow to moderately deep, moderately sloping soils of the uplands.
  - Unit IVe-3: Deep, gently sloping soils of the uplands in complexes with slickspot soil.
  - Unit IVe-4: Deep, moderately sloping, eroded soils of the uplands.

Class V. Soils not likely to erode but that have other limitations, impractical to remove, that limit their use largely to pasture or range, woodland, or wildlife food and cover.

Subclass Vw: Soils too wet for cultivation; drainage or protection not feasible.
- Unit Vw–1: Mixed sandy and clayey soils adjacent to stream channels and frequently flooded.
- Unit Vw–2: Loamy soils of bottom lands with meandering stream channels and frequently flooded.

Subclass Vs: Soils generally unsuitable for cultivation, because of moisture capacity or tilth.
- Unit Vs–1: Loamy soils of bottom lands, interspersed with few to numerous areas of a slick-spot soil.

Class VI. Soils that have severe limitations that make them generally unsuitable for cultivation and that limit their use largely to pasture or range, woodland, or wildlife food and cover.

Subclass VIe: Soils severely limited, chiefly by risk of erosion, if protective cover is not maintained.
- Unit VIe–1: Deep, clayey soil that has been severely eroded.
- Unit VIe–2: Deep, sandy soils in strongly undulating to duny areas of the uplands.
- Unit VIe–3: Mixed deep and shallow soils of the uplands.
- Unit VIe–4: Shallow, sloping soils of the uplands.
- Unit VIe–5: Deep and shallow soils in areas of Breaks.

Subclass VIs: Soils generally unsuitable for cultivation and limited for other uses by their moisture capacity, stones, or other features.
- Unit VIs–1: Clayey soils on flats and fans below areas of clay beds.

Class VII. Soils that have very severe limitations that make them unsuited to cultivation and that restrict their use largely to grazing, woodland, or wildlife.

Subclass VIIs: Soils very severely limited by moisture capacity, stones, or other soil features.
- Unit VIIs–1: Rough broken land.

Class VIII. Soils and landforms that have limitations that preclude their use for commercial production of plants and that restrict their use to recreation, wildlife, water supply, or esthetic purposes. (None in Cotton County.)

Management by capability units

The soils in one capability unit have about the same limitations and similar risks of damage. The soils in one unit, therefore, need about the same kind of management, though they may have formed from different kinds of parent material and in different ways. The capability units are described in the following pages, and management is suggested for the soils of each unit.

Judgment must be used in applying the suggestions given for using and managing the soils. On some soils a suggested practice may not be feasible, because areas of the particular soil are small and occur with larger areas of other soils that require different management. Also, terraces or contour farming would be desirable on some soils, but the size of the fields, the lay of the land, or other features may prohibit those practices. On some fields only stubble-mulch tillage can be used to help control erosion.

The uses suggested for the soils, the kinds of crops, and the practices suggested to help control erosion all must be adjusted to fit the individual farm. It is also necessary to consider the kind of soil and the way it has been managed in the past.

CAPABILITY UNIT I–1

This unit is made up of deep, nearly level soils of the uplands. The soils are well drained. The following soils are in this unit:

Chickasha loam, 0 to 1 percent slopes.
Lawton loam, 0 to 1 percent slopes.

These soils are moderately permeable and absorb rainfall readily. They are productive of the crops commonly grown and respond well to management, but they are subject to some erosion by wind. Growing a cover crop or using stubble-mulch tillage helps to protect the soils from wind erosion and improves their structure. Tillage should be kept to a minimum, and practices used to conserve moisture. Using terraces and tilling on the contour will help to impound water. The terraces and contour farming reduce the amount of runoff, and, as a result, more water soaks in.

These soils are suited to small grains, cotton, sudangrass, and alfalfa. A good cropping system that conserves moisture and helps to protect the soils from erosion is one in which a soil-improving crop, such as legumes or grasses, is grown 1 year in 6 and a high-residue crop 1 year in 5. Plant a cover crop after a low-residue crop or after cotton, peanuts, or other row crops. The cover crop will protect the soils during the winter. Irrigation improves the yields if the proper amounts of fertilizer have been applied and if other good management practices are used. Vary the depth of tillage to reduce the risk of forming a plowpan.

These soils are suited to pastures of bermudagrass, blue panic, and King Ranch bluestem. They are also suited to native tall grasses.

CAPABILITY UNIT I–2

The soils of this unit are deep, well drained, and nearly level. They are on bottom lands and on flats or benches of the high stream terraces. The following soils are in this unit:

Port clay loam.
Port loam.
Tipton loam, 0 to 1 percent slopes.

These are among the most productive soils for the crops commonly grown in the county. Some areas of the Port soils are flooded occasionally, but crops grown on them are not damaged seriously. An occasional diversion terrace is needed to help protect the soils of this unit from erosion caused by runoff from higher lying areas.

These soils are well suited to small grains, cotton, alfalfa, and sorghum. The main requirement in cultivating them is to maintain good soil structure in the plow layer. A desirable soil structure can be maintained and the supply of plant nutrients kept at a high level by using a suitable cropping system that will conserve moisture and protect the soils from erosion. A suitable cropping system is one in which a soil-improving crop is grown 1 year in 6 and a high-residue crop 1 year in 5. Stubble-mulch tillage or other good management of crop residues helps to maintain good soil structure and also increases the in-

filtration of water. The depth of tillage should be varied to reduce the risk of forming a compacted layer, or plowpan.

These soils are suited to pastures of bermudagrass, King Ranch bluestem, and blue panic. Suitable native range plants are big and little bluestem, Indiangrass, and switchgrass.

CAPABILITY UNIT IIe-1

The soils in this capability unit are deep and well drained. They are gently sloping and are on uplands and on high terraces along streams. The following soils are in this unit:

Enterprise very fine sandy loam, 1 to 3 percent slopes.
Tipton loam, 1 to 3 percent slopes.

These soils are easily tilled and are readily permeable to roots, air, and water. They contain a moderately large to large amount of organic matter and of available plant nutrients. The supplies of organic matter and plant nutrients are depleted rapidly, however, if large amounts of crop residues are not returned to the soils.

The risk of water erosion is moderate, but terraces and contour farming help to protect the soils. A cover crop or stubble-mulch tillage helps to protect them from wind erosion.

These soils are suited to all the crops commonly grown in the county, but wheat is the principal crop. If a wheat crop is lost because of drought or other causes, grain sorghum is generally planted as a catch crop. Cotton is considered the best cash crop to grow on these soils in the eastern part of the county. Alfalfa makes only poor yields. Normally, it does not grow vigorously beyond midsummer, because of the shortage of moisture. The soil-building value of an alfalfa crop is increased greatly if the crop is plowed under at the end of the rotation when the plants are about 12 inches high.

If terraces and contour farming are used, a good cropping system is needed that will conserve moisture and protect the soils from erosion. A suitable cropping system is one in which a soil-improving crop is grown 1 year in 6 and a high-residue crop 1 year in 5. If terraces are not used, seed the natural drainageways to alfalfa or grass. Small grains can be grown continuously if stubble-mulch tillage is used (fig. 19).

Alfalfa grown on these soils generally needs an application of nitrogen to establish a new seeding. It also responds well to annual applications of phosphate. Wheat responds well if nitrogen and phosphate are applied properly at planting time. Wheat yields are also improved by topdressing with nitrogen early in spring, if the moisture in the soil is ample. Most other crops respond well to commercial fertilizer. The kinds and amounts of fertilizer to apply should be determined by testing the soils.

These soils are suited to pastures of blue panic, bermudagrass, and King Ranch bluestem. They are also suited to native tall grasses for range.

CAPABILITY UNIT IIe-2

This unit consists of deep, well-drained, gently sloping soils of the uplands. The soils have a subsoil that is slowly permeable. The following soils are in this unit:

Lawton loam, 1 to 3 percent slopes.
Zaneis loam, 1 to 3 percent slopes.

***Figure 19.*—A field where stubble-mulch tillage has been practiced. The field is used to grow wheat.**

Because their subsoil is more slowly permeable than that of the soils in capability unit IIe-1, these soils lose more moisture through runoff and are not so well suited to crops that are grown in summer.

These soils are commonly used to grow small grains, cotton, grain sorghum, and alfalfa. Legumes can be grown as a cover crop in winter and should be included in the rotation. Crops that produce a large amount of residue ought to be grown on one-third of the tilled acreage each year. Using stubble-mulch tillage and cultivating on the contour help to conserve moisture and to reduce the risk of erosion. Cropping systems and management practices suitable for these soils are the same as those suggested for the soils in capability unit IIe-1.

The yields of small grains and row crops grown on these soils are improved by adding phosphate. Nitrogen also improves yields if the supply of available phosphorus in the soil is high. Irrigation improves yields if the proper kinds and amounts of fertilizer are added and if other management is good.

CAPABILITY UNIT IIw-1

Only one soil—Yahola fine sandy loam—is in this capability unit. It is a deep, nearly level soil of flood plains, and it is subject to occasional flooding. Crops grown on this soil, however, are damaged only slightly by floodwaters. The subsoil is moderately sandy and takes in water rapidly, but it holds only a moderate amount of water for plants to use. The risk of wind erosion is moderate. This soil is easily tilled and is readily permeable to roots, air, and moisture.

This soil is probably best suited to cotton and sorghum. In places diversion terraces and grassed waterways are needed to protect the soil from runoff from the higher lying areas. A cropping system that increases the supply of plant nutrients and that helps to control wind erosion is one in which a legume or grass crop is grown 1 year in 6 and a high-residue crop 1 year in 5. Stubble-mulch tillage should be used with this cropping system. If the amount of crop residue is small, grow rye and vetch as a cover crop in winter. The depth of tillage should be

varied from year to year to reduce the hazard of a plowpan forming.

Austrian winter peas or cowpeas are suitable legume crops to grow. Alfalfa is also suitable, but it is likely to be killed or damaged severely if the soil is flooded. Also, a stand of alfalfa is hard to maintain on the soil. Fertilizer should be applied as indicated by testing the soil.

This soil is suited to pastures of bermudagrass, King Ranch bluestem, and blue panic. Native range grasses that are suitable are big bluestem, switchgrass, and Indian grass.

CAPABILITY UNIT IIs-1

This capability unit consists of deep, nearly level soils that have a fine-textured subsoil. The soils are on uplands. The following soils are in this unit:

Foard silt loam, 0 to 1 percent slopes.
Waurika silt loam.

These soils are somewhat difficult to till and are very slowly permeable to roots, air, and water. They are moderately well supplied with organic matter and available plant nutrients. Much of the rainfall is lost through runoff. Yields are low because the soils are droughty and many of the seedlings do not emerge. The amount of water that soaks in can be increased and seedling emergence can be improved by using stubble-mulch tillage or other practices that reduce surface crusting.

These soils are suited to crops that mature early, that are resistant to drought, or that grow well in cool seasons. Some of these crops are wheat, oats, cotton, sorghum, sudangrass, winter peas, alfalfa, and sweetclover. The supply of plant nutrients can be increased and the structure of the soils maintained by (1) growing a soil-improving crop at least 1 year in 6 and a high-residue crop 1 year in 2, or (2) growing a high-residue crop and using continuously stubble-mulch tillage or other good methods to utilize the crop residues. Stubble-mulch tillage also helps to increase the amount of water that soaks into the soil. It maintains or increases the supply of plant nutrients if it is used with a soil-improving crop and if the proper kinds and amounts of fertilizer are added.

Some farmers in the county have increased their wheat yields substantially by growing the wheat after Austrian winter peas and after fertilizer, especially phosphate, was added. These practices also increase the yield of cotton that is grown after the wheat.

Deep-rooted legumes, such as alfalfa or sweetclover, can be used in the cropping system as a soil-improving crop. They improve the structure of the soil, increase the amount of moisture that penetrates the surface layer, and add organic matter and nitrogen. Alfalfa is commonly grown for hay or pasture. The hay is used on the farm or is sold as a cash crop. Generally, however, the hay is more profitably used to feed livestock on the farm and for soil building than as a cash crop. Sweetclover is commonly used for seed or pasture.

These soils are suited to pastures of King Ranch bluestem. Side-oats grama, blue grama, buffalograss, little bluestem, and switchgrass are suitable native range plants. Seeding a mixture of these native grasses is generally better than seeding a single kind.

CAPABILITY UNIT IIc-1

Only one soil—Enterprise very fine sandy loam, 0 to 1 percent slopes—is in this capability unit. It is a deep, nearly level soil that is friable. It is on uplands or terrace benches. The subsoil is moderately permeable.

This soil is susceptible to wind erosion. Maintaining the supply of plant nutrients and the structure of the soil are additional problems. In years of below-normal rainfall, the supply of moisture in the soil is often inadequate for good growth of crops. The soil is productive of common crops if it is well managed. It needs protection from erosion, and it requires fertilizer and practices that conserve moisture. Crops that are commonly grown are wheat, oats, cotton, and sorghum.

To protect the soil from wind erosion, use stubble-mulch tillage. This practice also improves the structure of the soil and allows more water to soak in. Constructing terraces that will impound water, and farming on the contour are optional, but they can be used to conserve moisture. Diversion terraces are needed in some places to break up concentrations of runoff water from higher lying areas.

A cropping system that helps to protect the soils from erosion and that conserves moisture is one in which a soil-improving crop is grown at least 1 year in 6. Plant a high-residue crop one-fifth of the remaining time in the rotation. After such low-residue crops as cotton or peanuts are grown, the soil should be protected by a cover crop in winter. Rye and vetch, grown as a cover crop, help to protect the soil from blowing. They also add plant nutrients if their residues are returned to the soil. Alfalfa or sweetclover also helps to increase the supply of plant nutrients and to improve the structure of the soil. Return the residue of the sweetclover to the soil.

Alfalfa makes only moderate yields on this soil. Normally, it does not grow vigorously beyond midsummer, because of the shortage of moisture. The soil-building value of an alfalfa crop is increased greatly if the crop is plowed under at the end of the rotation when the plants are still green and are about 12 inches high. To reduce the hazard of a plowpan forming, vary the depth of the tillage.

This soil is suited to pasture plants, such as bermudagrass, blue panic, and King Ranch bluestem. It is also suited to native tall grasses grown for range.

CAPABILITY UNIT IIIe-1

The soils in this capability unit are deep, moderately to slowly permeable, moderately sloping soils of the uplands. The following soils are in this unit:

Enterprise very fine sandy loam, 3 to 5 percent slopes.
Lawton loam, 3 to 5 percent slopes.
Zaneis loam, 3 to 5 percent slopes.

These soils lose a fairly large amount of moisture through runoff, but the supply of moisture is generally adequate for good growth of crops in summer. Runoff has caused slight to moderate erosion. The Enterprise soil is subject to wind erosion.

These soils are moderately productive of the crops commonly grown if they are well managed. They need management that protects them from erosion, conserves moisture, and provides proper kinds and amounts of fertilizer.

These soils are used mainly for wheat, oats, cotton, and sorghum.

Terraces and contour farming help to control erosion and to conserve moisture. If terraces and contour farming are used, a good cropping system should be chosen in which a soil-improving crop is grown at least 1 year in 5 and a high-residue crop 1 year in 4. To protect the soils in winter, plant a cover crop after a low-residue crop or after a soil-depleting crop that does not leave enough residue to protect the soils. If terraces are not used, a system that conserves moisture and protects the soils from erosion is that of growing sown crops continuously. Other suitable cropping systems, where terraces are not used, are those in which a soil-improving crop is grown at least 1 year in 5 or a high-residue crop is grown at least 1 year in 3. Perennial vegetation should be established in the natural drainageways. Use stubble-mulch tillage, or plant a cover crop of rye and vetch, to help protect the soils from wind erosion in winter. Vary the depth of tillage to reduce the risk of a plowpan forming.

The content of organic matter, the supply of plant nutrients, and the structure of the soil can be improved by growing alfalfa or sweetclover. The residue from sweetclover should be returned to the soils. The alfalfa should also be plowed under at the end of the rotation when the plants are still green and are about 12 inches high.

These soils are suited to pastures of bermudagrass, blue panic, and King Ranch bluestem. They are also suited to such native grasses as big and little bluestem, Indiangrass, switchgrass, and side-oats grama.

CAPABILITY UNIT IIIe-2

The soils in this capability unit are deep and have a clayey subsoil. They are gently sloping and are on uplands. The following soils are in this unit:

Foard and Tillman silt loams, 1 to 3 percent slopes.
Tillman silt loam, 1 to 3 percent slopes.

These soils absorb water very slowly and lose much of it through runoff. They are droughty and subject to erosion. An occasional area where a slickspot soil occurs is common in Foard and Tillman silt loams, 1 to 3 percent slopes.

Small grains are the main crops grown on these soils, although sorghum and some cotton are grown. High yields of wheat are obtained only if the soils are protected from erosion, if the moisture is conserved, and if fertilizer is added. Small grains mature before there is a shortage of moisture. Therefore, the yields of small grains are more dependable than those of crops that mature in summer.

If terraces and contour farming are used, a cropping system that conserves moisture and protects the soils from erosion is one in which a soil-improving crop is grown at least 1 year in 5 and a high-residue crop 2 years in 3. If row crops are grown, plant a cover crop after the row crop is harvested, to protect the soils in winter. Stubble-mulch tillage helps to conserve moisture and improves the structure of the soils. Austrian winter peas and other winter legumes can be used in the wheat rotation to improve the supply of plant nutrients and to improve the structure of the soils. Small grains need phosphate and some nitrogen. Winter legumes need phosphate.

A grass that is suitable for pastures on these soils is King Ranch bluestem. Little bluestem, blue grama, side-oats grama, and buffalograss are suitable native grasses. Seeding a mixture of native grasses is better on these soils than seeding only one kind.

CAPABILITY UNIT IIIe-3

Only one soil—Vernon clay, 1 to 3 percent slopes—is in this capability unit. It is a shallow to moderately deep, gently sloping soil of the uplands and overlies reddish, calcareous clay beds.

The calcareous clay near the surface and the risk of water erosion are problems in areas where this soil is cultivated. Maintaining the supply of plant nutrients and the structure of the soil are important management requirements. The soil is somewhat droughty because runoff is rapid.

This soil is used for wheat and sorghum. Wheat, however, is the more suitable crop to grow because it matures before the hot summer months arrive.

To conserve moisture and to protect the soil from erosion, farm on the contour and construct terraces that lead to a grassed waterway. Use a cropping system in which a soil-improving crop is grown at least 1 year in 4 and a high-residue crop is grown at least half of the time to maintain the supply of plant nutrients and the structure of the soil. If terraces are not used, establishing perennial vegetation in natural drains will conserve moisture and protect the soil from erosion. Also, grow a soil-improving crop one-third of the time and a high-residue crop year after year. Use crop-residue management or stubble-mulch tillage on the contour whether terraces are used or not.

The yields of wheat can be improved by adding phosphate and nitrogen. Additional nitrogen is needed when large amounts of straw or other crop residues are plowed under.

King Ranch bluestem is a suitable grass to grow for pasture on this soil. Suitable native range grasses are side-oats grama, blue grama, and buffalograss.

CAPABILITY UNIT IIIe-4

This capability unit consists of sandy soils that are subject to severe wind erosion. The soils are on uplands. The following soils are in this unit:

Pratt loamy fine sand, undulating.
Shellabarger loamy sand, 0 to 4 percent slopes.

These soils have a medium to high capacity for storing moisture that plants can use. There is little runoff from the areas. The soils are low in fertility. They are not droughty, however, and are moderately productive of the crops commonly grown if they are well supplied with fertilizer. Plants grown on them respond well to rainfall in summer.

Cotton, sorghum, and some small grains are the principal crops grown on these soils. Using terraces and cultivating on the contour are not practical. Managing crop residues carefully and protecting the soils with a cover crop in winter will help to control wind erosion. Tilling these soils should be delayed until time to prepare a seedbed. A trashy cover ought to be maintained as long as practicable to help prevent wind erosion. Refrain from cultivating row crops late in spring to allow native

vegetation to grow. Plant a cover crop after a row crop to protect the soils in winter, and use stubble-mulch tillage. Where sorghum is grown, leave the stalks standing for additional protection.

A good cropping system that will conserve moisture and help to protect the soils from erosion is one in which a soil-improving crop is grown 1 year in 4 and a high-residue crop at least 1 year in 2. A cover of perennial vegetation should be established in the drainageways. Windbreaks or stripcropping can be used to help control wind erosion. Planting a row crop in strips and grain sorghum in adjacent strips is a good practice. The strips are alternated each year and are run at right angles to the direction of prevailing winds. Rye and vetch should be grown after the row crop to provide a cover in winter. They are then plowed under as green manure. The next season, sorghum can be planted in the strips where the rye and vetch were plowed under, and other row crops can be planted in the strips where the sorghum was grown. Melons and sweetpotatoes can be grown in alternate strips with sorghum.

Suitable pasture plants on these soils are bermudagrass and weeping lovegrass. Native tall grasses, such as little bluestem, sand bluestem, switchgrass, Indiangrass, and sand lovegrass, are suitable for range.

CAPABILITY UNIT IIIs-1

Only Foard-slickspot complex, 0 to 1 percent slopes, is in this capability unit. This complex consists of deep, nearly level, very slowly permeable soils of the uplands. It includes few to many slightly depressed areas where the slickspot soil occurs.

The severe crusting on the surface and the claypan in the subsoil make these soils very slowly permeable. Even on slight slopes, the soil does not absorb all the rainfall, and much runoff occurs; therefore, the soils are droughty. Because of the clayey subsoil and the amount of salts in the soils, water is released slowly to plants. Maintaining a good supply of plant nutrients and a favorable structure are management problems.

Small grains and some cotton and sorghum are the main crops. The yields of small grains are more dependable than those of other crops because small grains mature before the hot, dry weather in summer. High yields are obtained, however, only in years of above-normal rainfall. Small grains need phosphate and some nitrogen in years when moisture is abundant. Only deep-rooted crops grow well in summer. Austrian winter peas and other winter legumes can be included in the wheat rotation.

Good practices to conserve moisture and to protect the soils from erosion consist of (1) growing a soil-improving crop at least 1 year in 4 and (2) growing a high-residue crop the rest of the time. Agricultural gypsum will improve the structure of the soils, reduce surface crusting and runoff, and increase the amount of water that soaks in. It should be applied at the rate of 2 to 4 tons per acre. Stubble-mulch tillage also increases the amount of water that soaks in and improves tilth. Adding trash from cotton gins or adding other organic material reduces surface crusting.

King Ranch bluestem and native short grasses are suitable for pasture or range on these soils.

CAPABILITY UNIT IIIs-2

Only one soil—Miller clay—is in this capability unit. This is a deep, nearly level soil of the bottom lands that has slow runoff.

If clean tillage is used on this soil, the surface layer tends to run together when wet and crusts severely when dry. Tillage implements should be used that open up the soil and leave crop residues on or near the surface. The soil is slowly permeable to roots, air, and water. Keeping a cover of crop residue on the surface or plowing crop residue under increases the amount of water that soaks in and reduces surface crusting.

This soil is flooded occasionally. The surface drainage could be improved by land leveling. Conserving moisture is the major problem during dry periods. Good management of the crop residue helps to conserve moisture in the soil and helps to maintain the content of organic matter, the supply of plant nutrients, and the structure of the soil. A cropping system in which a soil-improving crop is grown 1 year in 6 and a high-residue crop is grown 1 year in 5 also helps to maintain the supply of plant nutrients and the structure of the soil. The best cropping system consists of growing sown crops year after year. Fertilizer, applied according to the results of soil tests, improves the yields of wheat and helps decompose the crop residue.

This soil is suited to pastures of King Ranch bluestem and bermudagrass. The native range grasses suitable for this soil are little bluestem, Indiangrass, switchgrass, blue grama, and buffalograss.

CAPABILITY UNIT IVe-1

Only one soil—Enterprise very fine sandy loam, 5 to 8 percent slopes—is in this capability unit. It is a deep, moderately permeable, strongly sloping soil of the uplands.

This soil is low to moderate in productivity. The supply of plant nutrients is low to moderate. The soil absorbs water moderately well but loses large amounts of it through runoff. Both water erosion and wind erosion are problems. Sheet and gully erosion are dominant and must be controlled if this soil is to remain in cultivation.

This soil is better suited to grass than to cultivated crops, but cultivated crops can be grown under careful management. If terraces and contour farming are used, a suitable cropping system is that of growing a high-residue crop continuously. Growing a soil-improving crop at least 1 year in 4 increases the supply of plant nutrients. Proper management of crop residues, such as stubble-mulch tillage, reduces runoff. Runoff water from the terraces should be directed to safe channels through grassed waterways. On land that has not been terraced, establish perennial vegetation in the drains. Grow sown crops continuously that produce a large amount of residue. Growing a soil-improving crop at least 1 year in 4 increases the supply of plant nutrients. Vary the depth of tillage to reduce the risk of forming a plowpan, or a layer of compacted soil, at plow depth. Managing crop residues carefully and growing a legume as a cover crop in winter help to control wind erosion. The yields of small grains can be improved by adding phosphate and nitrogen.

The grasses suitable for pasture and range on this soil are the same as those listed for capability unit IIIe-1.

CAPABILITY UNIT IVe-2

Only one mapping unit—Vernon soils, 3 to 5 percent slopes—is in this capability unit. The soils are moderately sloping and are shallow to moderately deep over reddish, calcareous clay beds. They are in the uplands.

In areas of these soils that are cultivated, practices are needed to maintain the supply of plant nutrients and the structure of the soils. The soils also need to be protected from erosion by water. They are probably best suited to grass, but they are used for small grains and, to some extent, for sorghum.

If terracing and contour farming are used, a cropping system that helps to control erosion is one in which a close-drilled or a high-residue crop is grown at least 1 year in 2. Growing a soil-building or soil-improving crop at least 1 year in 4 improves the tilth and allows more water to soak into the soils. Using a suitable cropping system and stubble-mulch tillage returns large amounts of crop residue to the soils. The crop residue helps to maintain or increase the supply of plant nutrients and improves the soil structure. If terraces are not used, only a crop that produces a large amount of residue should be grown, and a soil-improving crop needs to be grown at least 1 year in 3. Small grains grown on these soils respond well if proper amounts of fertilizer are added.

Moderate crop yields can be expected if these soils are well managed. The management should include practices to conserve moisture and to protect the soils from erosion. Perennial vegetation ought to be established in the drainageways.

King Ranch bluestem is a suitable pasture plant for these soils. The native range plants suitable for these soils are side-oats grama, blue grama, buffalograss, and little bluestem.

CAPABILITY UNIT IVe-3

The soils in this capability unit are deep and gently sloping. They consist of soils that are mapped in complexes with a slickspot soil. The soils are on uplands. The following soils are in this unit:

Foard-slickspot complex, 1 to 3 percent slopes.
Zaneis-slickspot complex, 1 to 3 percent slopes.

Crusting of the surface, the concentration of salts, and the slow rate of infiltration make surface runoff and accelerated erosion serious problems in areas where the slickspot soil occurs. The soils release moisture slowly, and much of the moisture in the soils is not available to plants, because of the salts. The soils are therefore droughty.

These soils are better suited to native grasses than to field crops, but small grains and some cotton and sorghum are grown. The grasses form a cover that helps to protect the soils from erosion. The native grasses are dormant during long, dry periods, but they become green and make additional growth when water is again available during the growing season.

Diversion terraces and protected waterways should be used, where needed, to help control erosion. Establish perennial vegetation in the natural drains. A system that conserves moisture and helps to control erosion is that of growing sown crops continuously. Stubble-mulch tillage is necessary. Add proper amounts of fertilizer when the moisture in the subsoil is adequate. All tillage operations, except moldboard plowing, ought to be at a depth of not more than about 4 inches.

Special treatment of the areas where the slickspot soil occurs include practices such as adding a mulch material at the rate of 3 to 4 tons per acre. Good materials to use for mulch are cotton burs, straw, or hay. Apply about 20 pounds of nitrogen per ton of mulch to speed decomposition and to add plant nutrients. If gypsum is used, add mulch also to the areas where the gypsum has been applied. The areas that have been given special treatment should not be cultivated for at least 2 years.

King Ranch bluestem and native short grasses are suitable for pasture or range on these soils.

CAPABILITY UNIT IVe-4

This capability unit consists of soils that have been eroded by water. The soils are deep and moderately sloping, and they are on the uplands. The following soils are in this unit:

Lawton loam, 3 to 5 percent slopes, eroded.
Zaneis loam, 3 to 5 percent slopes, eroded.

Controlling water erosion and maintaining the supply of plant nutrients and the structure of the soils are the primary problems in using these soils for crops. The soils are probably best suited to grass, but they can be cultivated if they are managed carefully. The crops commonly grown are cotton, sorghum, and some wheat, oats, and barley.

If row crops are to be grown on these soils, establish terraces and grassed waterways and till the soils on the contour. Grow a soil-improving crop at least 1 year in 4 and a high-residue crop the rest of the time. Use stubble-mulch tillage to increase the amount of water that soaks in and to improve the structure of the soils. If terraces are not used, establish perennial vegetation in the natural drains. Sown crops that produce a large amount of residue can be grown year after year if stubble-mulch tillage is used. The depth of tillage should be varied to reduce the risk of forming a plowpan.

Close-growing crops, Austrian winter peas, or grasses are the best soil-improving crops, but alfalfa and sweetclover are also suitable. Return the residue of the sweetclover to the soils. Alfalfa is suitable for soil improvement if the crop is plowed under when it is still green and has at least 12 inches of top growth. All crops grown on these soils respond to fertilizer if it is applied in amounts indicated by testing the soils.

The pasture plants and native grasses that are suitable for these soils are the same as those given for capability unit IIIe-1.

CAPABILITY UNIT Vw-1

Only one mapping unit—Lincoln soils—is in this capability unit. It consists of mixed sandy and clayey soils that are adjacent to the channels of streams. The soils are frequently flooded.

Some areas of these soils are on sandy bottom lands that are dissected by meandering streams. Others are on low, sandy ridges or in occasional clayey swales. Cultivation is not practicable, because the soil material is shifted and is redeposited by wind and water, and it is moved about when the streams change their course. The soils are suited

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to grass, and moisture is adequate for grass, but there are scattered stands of trees. The acreage is used mainly for native range and pasture. The more sandy areas are subject to wind erosion if they are overgrazed.

The management of these soils used for range is discussed in the section "Range Management."

CAPABILITY UNIT Vw-2

Broken alluvial land is the only land type in this capability unit. It consists of areas of loamy bottom land that are dissected by streams. The areas lie between the streams and are small and frequently flooded. Therefore, cultivation is not practicable. Some areas have thin stands of trees, but grass is dominant in most areas.

This land type is used for pasture and range. Its management is discussed in the section "Range Management."

CAPABILITY UNIT Vs-1

Only Port-slickspot complex is in this capability unit. This complex consists of loamy soils interspersed with areas that are occupied by a slickspot soil. The soils are on bottom lands. Most of the areas have a cover of grass, but some areas of the slickspot soil are bare. The soils are used mainly for pasture and are not suited to cultivated crops. The management of this capability unit is described in the section "Range Management."

CAPABILITY UNIT VIe-1

Eroded clayey land is the only land type in this capability unit. It consists of deep, clayey soil material that has been severely eroded. Runoff is rapid because of the strong slopes and the clayey texture of the soil material. Therefore, the soil material is droughty. Nearly all of this land type was once used for crops, but it has since been abandoned. Most of these eroded areas have been seeded to native grasses.

This land type is suited only to permanent vegetation, and only fair yields of forage can be obtained under good management. The areas are probably best protected from further erosion by keeping them under a cover of grass. Management is described in the section "Range Management."

CAPABILITY UNIT VIe-2

This capability unit consists only of Pratt and Tivoli soils, rolling. The soils are deep and sandy, and they are strongly undulating to duny. They occur on the uplands.

These soils are subject to severe wind erosion if they are cultivated. They absorb water rapidly, but the deep sands retain little moisture for plants. Consequently, these soils are droughty in midsummer and are not suited to cultivated crops.

These soils are probably best used for grazing. If grazing is controlled, they support a good cover of native tall grasses. If they are kept under grass, the soils are stabilized and little erosion occurs. Nearly all of the areas have a cover of grass. The management of this capability unit is described in the section "Range Management."

CAPABILITY UNIT VIe-3

This capability unit consists of mixed deep and shallow soils of the uplands. The following soils are in this capability unit:

Lucien-Zaneis-Vernon complex.
Zaneis soils, severely eroded.

These soils are mainly in native grasses, and they are suited only to range. The Zaneis soils are subject to further erosion unless good management is used.

Fair yields of tall native grasses are obtained on these soils under good management. The management of these soils for range is discussed in the section "Range Management."

CAPABILITY UNIT VIe-4

This capability unit consists only of Vernon soils, 5 to 12 percent slopes. The soils are shallow over bedrock and are on the uplands.

These steep, clayey soils have a few rock outcrops. Runoff is rapid because of the steep slopes and the clayey subsoil. The soils are droughty. If thick stands of grass are grown, runoff will be reduced and more water will soak into the soils.

These soils are suited only to permanent vegetation. The management for range is given in the section "Range Management."

CAPABILITY UNIT VIe-5

Only Breaks-alluvial land complex is in this capability unit. It consists of deep and shallow soils in areas of Breaks. The soil material on the side slopes of the Breaks is shallow over bedrock and is clayey and steep. The areas of alluvial land are subject to flooding. In most of this complex, the soil material is droughty and is subject to severe erosion.

This complex is suited only to permanent vegetation. The management is discussed in the section "Range Management."

CAPABILITY UNIT VIs-1

This capability unit is made up of Treadway soils. These soils consist of reddish, compact, clayey soil material over alluvium and colluvium. They are on aprons, fans, flats, and flood plains below areas of clay beds, or areas of Rough broken land that has been subjected to severe geologic erosion. Because the soils are low in fertility and are droughty, they are not suited to cultivated crops. In places there are many scrubby mesquite trees. The soils are suitable only for pasture or range, but they are low in productivity. The management for this capability unit is given in the section "Range Management."

CAPABILITY UNIT VIIs-1

Only Rough broken land is in this capability unit. It consists of very shallow, steep, clayey soil material and of rock outcrops.

This land type occurs within areas of the Vernon soils. It has undergone severe geologic erosion. In most places it is steep and rough, but there are some more nearly level areas. Rocks, ranging in size from pebbles to boulders, are frequently on the surface. This land type has little value for grazing, but most of the acreage is included within areas used for range. The management of this capability unit is described in the section "Range Management."

Estimated Yields Under Dryland Farming [2]

Table 2 lists, for each soil, the estimated average yields per acre of the principal dryland crops grown in Cotton County under two levels of management. The yield figures given are estimated long-time averages. Crop failures have been included in the averages.

The estimates are based partly on interviews with farmers and partly on records of fertility studies, on crop variety tests, and on the results of rotation and tillage trials recorded by the Oklahoma Agricultural Experiment Station. The experiments were conducted on permanent experimental sites and on plots of cooperating farmers.

The yields in columns A are those obtained under common management, which requires the following practices: (1) Using proper rates of seeding, proper dates of planting, and efficient methods of harvesting; (2) controlling weeds, insects, and diseases sufficiently to insure the growth of plants; (3) using terraces and contour tillage where necessary; (4) using little or no fertilizer; and (5) using a moldboard or one-way plow.

TABLE 2.—*Estimated average yields per acre of the principal crops grown under dryland farming under two levels of management*

[Yields in columns A are those obtained over a period of years under common management; yields in columns B are those to be expected under improved management. Absence of yield figure indicates that the soil is not suited to the crop specified or that the crop is not commonly grown]

Soil	Capability unit	Wheat		Oats		Grain sorghum		Forage sorghum		Cotton (lint)		Alfalfa	
		A	B	A	B	A	B	A	B	A	B	A	B
		Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons* [1]	*Tons* [1]	*Lb.*	*Lb.*	*Tons* [2]	*Tons* [2]
Breaks-alluvial land complex	VIe-5	----	----	----	----	----	----	----	----	----	----	----	----
Broken alluvial land	Vw-2	----	----	----	----	----	----	----	----	----	----	----	----
Chickasha loam, 0 to 1 percent slopes	I-1	14	20	27	38	20	30	2. 3	3. 1	240	320	1. 2	2. 2
Enterprise very fine sandy loam, 0 to 1 percent slopes.	IIc-1	17	22	30	40	22	28	2. 5	3. 3	250	325	1. 4	2. 4
Enterprise very fine sandy loam, 1 to 3 percent slopes.	IIe-1	15	20	26	36	20	26	2. 3	3. 0	230	305	----	----
Enterprise very fine sandy loam, 3 to 5 percent slopes.	IIIe-1	13	18	23	33	18	24	2. 1	2. 8	200	270	----	----
Enterprise very fine sandy loam, 5 to 8 percent slopes.	IVe-1	----	----	----	----	----	----	1. 8	2. 5	----	----	----	----
Eroded clayey land	VIe-1	----	----	----	----	----	----	----	----	----	----	----	----
Foard silt loam, 0 to 1 percent slopes	IIs-1	12	16	20	28	15	20	1. 6	2. 2	175	220	----	----
Foard-slickspot complex, 0 to 1 percent slopes	IIIs-1	9	13	15	23	12	17	1. 3	1. 8	----	----	----	----
Foard-slickspot complex, 1 to 3 percent slopes	IVe-3	8	12	13	21	11	16	1. 2	1. 7	----	----	----	----
Foard and Tillman silt loams, 1 to 3 percent slopes.	IIIe-2	11	15	18	26	14	19	1. 5	2. 0	160	200	----	----
Lawton loam, 0 to 1 percent slopes	I-1	14	19	27	37	18	26	2. 3	3. 0	220	285	1. 2	2. 1
Lawton loam, 1 to 3 percent slopes	IIe-2	13	18	25	35	16	24	2. 1	2. 8	200	265	----	----
Lawton loam, 3 to 5 percent slopes	IIIe-1	11	16	23	32	14	21	1. 8	2. 5	165	225	----	----
Lawton loam, 3 to 5 percent slopes, eroded	IVe-4	10	15	20	29	12	19	1. 6	2. 3	----	----	----	----
Lincoln soils	Vw-1	----	----	----	----	----	----	----	----	----	----	----	----
Lucien-Zaneis-Vernon complex	VIe-3	----	----	----	----	----	----	----	----	----	----	----	----
Miller clay	IIIs-2	18	23	30	40	25	32	2. 4	3. 3	260	330	----	----
Port clay loam	I-2	21	29	40	52	28	38	2. 7	3. 6	320	410	2. 8	3. 6
Port loam	I-2	21	29	38	48	30	40	2. 7	3. 5	320	410	2. 5	3. 4
Port-slickspot complex	Vs-1	----	----	----	----	----	----	----	----	----	----	----	----
Pratt loamy fine sand, undulating	IIIe-4	----	----	----	----	----	----	2. 0	2. 5	180	250	----	----
Pratt and Tivoli soils, rolling	VIe-2	----	----	----	----	----	----	----	----	----	----	----	----
Rough broken land	VIIs-1	----	----	----	----	----	----	----	----	----	----	----	----
Shellabarger loamy sand, 0 to 4 percent slopes	IIIe-4	----	----	----	----	19	27	1. 9	2. 5	175	250	----	----
Tillman silt loam, 1 to 3 percent slopes	IIIe-2	14	19	26	36	16	22	2. 0	2. 8	200	260	----	----
Tipton loam, 0 to 1 percent slopes	I-2	18	23	32	42	25	35	2. 6	3. 4	275	350	1. 5	2. 5
Tipton loam, 1 to 3 percent slopes	IIe-1	16	20	28	36	22	30	2. 3	3. 1	250	325	----	----
Treadway soils	VIs-1	----	----	----	----	----	----	----	----	----	----	----	----
Vernon clay, 1 to 3 percent slopes	IIIe-3	8	12	----	----	11	16	1. 2	1. 7	----	----	----	----
Vernon soils, 3 to 5 percent slopes	IVe-2	7	10	----	----	----	----	----	----	----	----	----	----
Vernon soils, 5 to 12 percent slopes	VIe-4	----	----	----	----	----	----	----	----	----	----	----	----
Waurika silt loam	IIs-1	12	17	20	30	15	22	1. 6	2. 4	175	235	----	----
Yahola fine sandy loam	IIw-1	17	23	32	42	28	38	2. 5	3. 4	300	390	2. 2	3. 0
Zaneis loam, 1 to 3 percent slopes	IIe-2	13	19	25	35	18	26	2. 0	2. 8	200	285	----	----
Zaneis loam, 3 to 5 percent slopes	IIIe-1	11	17	22	32	16	24	1. 8	2. 6	165	250	----	----
Zaneis loam, 3 to 5 percent slopes, eroded	IVe-4	10	16	20	30	15	23	1. 6	2. 4	130	200	----	----
Zaneis soils, severely eroded	VIe-3	----	----	----	----	----	----	----	----	----	----	----	----
Zaneis-slickspot complex, 1 to 3 percent slopes	IVe-3	8	12	16	25	13	18	1. 5	2. 0	----	----	----	----

[1] Ovendry weight.
[2] Field-cured weight.

[2] This section was prepared in cooperation with ROY M. SMITH, soil scientist, Oklahoma Agricultural Experiment Station.

The yields in columns B are those obtained under improved management, which requires the following practices: (1) Using proper rates of seeding, proper dates of planting, and efficient methods of harvesting; (2) controlling weeds, insects, and diseases; (3) using terraces and contour tillage where necessary; (4) applying fertilizer in amounts indicated by soil tests; (5) using suitable crop varieties; (6) planting cover crops on sandy soils subject to wind erosion; (7) using stubble-mulch tillage on sandy and loamy soils; (8) plowing early and leaving a rough, trashy surface where erosion is a hazard; and (9) using a cropping system that is suited to the operator's goal and the needs of the specific soil.

Irrigation [3]

About 1,600 acres was irrigated in Cotton County in 1959. It should be possible to increase this acreage to some extent because it is estimated that enough water is available to irrigate approximately 5,500 acres.

Sources and quality of water

Nearly all the acreage that is irrigated is on the bottom lands along Cache Creek. The water from this creek is of good quality, but it is of limited quantity. At the upper end of the creek, a large part of the flow in dry seasons is made up of sewage from Lawton and Fort Sill. At the lower end of the creek, the water supply is fairly stable at all times. Minor sources of irrigation water are a few low-producing, shallow wells in the southeastern part of the county and a few spring-fed sloughs. Not many ponds are available.

Constructing large farm ponds for storing water will increase the amount of water available for irrigation. Their cost in relation to the benefits that are derived, however, may be too high for them to be profitable. Ponds for storing irrigation water require from 2.5 to 3.0 acre-feet of storage space for each acre to be irrigated.

If irrigation is to be profitable, the number of acres irrigated should be commensurate with the quantity of water available. It is poor economy to spread a limited supply of water over too large an area. The water proposed for irrigation should be tested for quality also as one of the first steps in setting up an irrigation system.

Methods of irrigation

About 10 percent of the irrigated land in Cotton County is irrigated by the sprinkler method of application. The rest is about equally divided between that irrigated by the parallel-border method and that irrigated by the graded-furrow method. Both the border and furrow methods of irrigation require that the area be leveled.

Suitability of soils for irrigation

Generally, for profitable irrigation, a soil must meet certain requirements. It must be productive, it must absorb and store large quantities of water available for plants, and it must have fairly little slope and adequate drainage. In addition, the soil must be permeable enough to permit leaching of harmful salts, and it must have enough depth to insure sufficient feeding area for the roots of plants. Table 3 gives the available water-holding capacity and the rates of infiltration for the soils of Cotton County that are suitable for irrigation.

TABLE 3.—*Available water-holding capacity and water-intake rate of soils suitable for irrigation*

Soil	Estimated available water-holding capacity	Estimated basic water-intake rate
	Inches per inch	*Inches per hour*
Chickasha loam	0.14	0.45
Enterprise very fine sandy loam	.14	.90
Foard silt loam	.17	.15
Lawton loam	.14	.45
Miller clay	.17	.05
Port clay loam	.17	.45
Port loam	.14	.90
Pratt loamy fine sand, undulating	.07	1.60
Tillman silt loam	.17	.30
Tipton loam	.14	.65
Waurika silt loam	.17	.15
Yahola fine sandy loam	.12	.90
Zaneis loam	.14	.30

By available water in the soil is meant the amount of moisture that can be taken up by the plant in amounts needed for growth. For a given soil, the available water capacity is the range between field capacity and the level at which a mature plant begins to wilt. A soil that has low water-holding capacity must have irrigation water frequently if the proper amount of moisture is to be maintained.

The intake rate of a soil indicates, in inches, the amount of water that the soil will absorb in an hour. The intake rates shown in table 3 are considered to be the normal rate of infiltration. Rates may vary greatly, however, because of differences in the tilth of the plow layer, in the content of organic matter in the soil, and in various other factors.

Yields of crops under irrigation

The crops to be grown and their expected yields under irrigation should be considered in determining the feasibility of irrigating the soils. Cotton, alfalfa, and sorghum have been grown successfully under irrigation in this county. Consult a technician of the Soil Conservation Service for information about increases in crop yields you can expect as the result of irrigating.

Range Management [4]

From 45 to 50 percent of the acreage in Cotton County is used for native range and pasture. Most of the acreage in native range is not suited to cultivated crops. Some areas were formerly cultivated but were later seeded to native grasses because they were eroded or too low in fertility for good growth of field crops.

Most of the land used for range is in livestock farms and general farms, and the native grasses are used to graze beef cattle. Feeder and stocker calves, usually sold when they are weaned, are the main source of income from

[3] Prepared with the help of HARRY A. ELAM, agricultural engineer, Soil Conservation Service.

[4] By CHESTER FRY, range conservationist, Soil Conservation Service.

livestock. The range is grazed throughout the year except where supplemental grazing is provided by tame pasture or by areas generally used for crops. There are few true ranches in Cotton County, and they are smaller than those in other parts of the State.

Range sites and condition classes

Range sites are distinctive kinds of rangeland that produce significantly different kinds or amounts of native, or climax, vegetation. A significant difference means one large enough to require different management, such as a different stocking rate. In this county there are only moderate differences in the elevation, and the average amount of rainfall is fairly uniform throughout the county. Therefore, these factors do not influence the determination of the range sites.

The vegetation that grew originally on a site, or the climax vegetation, is generally the most productive and most suitable for that particular site. Most of the plants in the climax vegetation are palatable and nutritious for grazing animals. The kind and amount of vegetation presently on a range site is seldom the same as that on it originally. The present vegetation is determined by grazing use and by management that includes such cultural practices as cultivation and control of weeds and brush.

Range condition, the present state of the vegetation on a particular site in relation to the climax vegetation for that site, is a method of rating deterioration of range. Its purpose is to establish a basis for predicting the degree of improvement possible under good management. The four range condition classes are defined as follows:

Condition class:	*Percentage of present vegetation that is climax for the site*
Excellent	76 to 100
Good	51 to 75
Fair	26 to 50
Poor	0 to 25

A range site in excellent condition has almost the maximum climax vegetation for the site and the climate. Continued good grazing management will maintain this high productivity. The amount of forage produced, however, fluctuates considerably with seasonal changes in climate.

If range is in good condition, there is opportunity to increase the production of forage rapidly by managing grazing to encourage the better plants. The actual time required to improve the range to excellent condition through management is naturally influenced by the weather. Improvement is slowed by dry weather lasting a year or more.

A range in fair condition is unsatisfactory. The plant cover has been damaged, and in places the soil is subject to erosion. Deferring grazing during the growing season is generally required for rapid improvement. Supplemental summer pasture can be used to make this possible, and weeds or woody plants may need to be controlled on some sites to speed recovery.

A range site in poor condition has lost so much of the stand of desirable forage plants that it produces only a fraction of the forage it is capable of producing. Few, if any, of the original productive range plants remain. Most of the vegetation is neither very palatable nor very productive. The soil is subject to erosion and may already be actively eroding. Restoring poor range to full productivity is difficult, and it requires a long period of time. Using supplemental summer pasture, deferring grazing, and controlling weeds and woody plants are required. Seeding is also necessary.

To help determine the condition of the range, the components of the vegetation on a specific range site are grouped according to their response to grazing. The categories used are *decreaser plants*, *increaser plants*, and *invader plants.*

Decreaser plants are the kinds of plants in the climax vegetation that decrease under continued heavy grazing. These are generally the most productive and most palatable perennial plants. They tend to increase when grazing pressure is reduced sufficiently.

Increaser plants are the kinds of plants in the climax vegetation that generally increase in abundance as the number of decreaser plants declines. Plants that increase at first may subsequently decrease as heavy use is continued. Increaser plants are normally shorter, less productive, and less palatable than other plants in the climax vegetation. Most increasers tend to decrease under light use, but for some plants of this kind, such as western ragweed and pricklypear, other measures of control may be required.

Invader plants do not grow naturally on the specific site. They may be a part of the natural vegetation of nearby sites, or they may have come from an area a great distance away. Under the management used on rangeland, they are generally less productive, less palatable, or less dependable than the climax plants for the site.

Trends in range condition.—Range condition classifies the present vegetation of a range site, but it does not indicate whether the range is improving or deteriorating. The trend must frequently be considered in planning the grazing management needed to maintain or improve the range. Following are some of the factors that indicate a trend in range condition.

Plant vigor is reflected primarily by the size of the plant and its parts in relation to its age and the environment in which it is growing. Evidence of increased vigor of decreaser plants indicates that the range is improving.

Abundance of seedlings and young plants of the species that are most palatable to livestock is evidence that the range is improving. Few seedlings are able to establish themselves, however, on range in excellent condition.

A change in the composition of the plants on a range indicates a trend in range condition. A decrease in the number of decreaser plants is an indication of a decline in range condition. Likewise, an increase in the number of decreasers is an indication of improvement in range condition. Generally, the invasion of plants not native to the site indicates a decline in range condition.

An accumulation of plant residues is an indication of improving range condition. Plant residues reduce erosion caused by splashing raindrops and make the surface of the soil more favorable for establishing seedlings and for the intake of moisture.

The condition of the soil surface affects the trend in range condition and the rate of range recovery. Evidence of an increase in bare ground, soil crusting, compaction from trampling, hummocking, and erosion indicate a declining trend in range condition.

Descriptions of range sites

The soils of Cotton County have been grouped in the range sites described in the following pages. The description of each range site gives the important characteristics of the soils and the names of the principal grasses.

ALKALI BOTTOM LAND

Only the slickspot soil in the Port-slickspot complex is in this range site. This soil is associated with loamy soils formed in alluvium. The associated soils are in the Loamy Bottom Land range site. The concentration of salts and the subsoil of compact clay in the slickspot soil limit vegetation to plants that resist drought and that tolerate salt.

Production is normally low. The dominant vegetation varies according to the severity of the effect of the alkali. The more severely affected areas have no vegetation. Progressively, rhombopod, whorled dropseed, inland saltgrass, alkali sacaton, white tridens, and blue grama grow as the concentration of alkali decreases.

HARDLAND

The Hardland site consists of soils that have a surface layer of silt loam and a subsoil of heavy clay. The soils are nearly level to gently sloping. The following soils and the areas indicated in the three complexes are in this site:

Breaks-alluvial land complex (hardland portion).
Foard silt loam, 0 to 1 percent slopes.
Foard and Tillman silt loams, 1 to 3 percent slopes.
Foard-slickspot complex, 0 to 1 percent slopes (Foard portion).
Foard-slickspot complex, 1 to 3 percent slopes (Foard portion).
Tillman silt loam, 1 to 3 percent slopes.
Waurika silt loam.

The yields of forage are limited on this site because these soils are droughty. About 60 percent of the climax vegetation is decreaser plants, such as side-oats grama, blue grama, western wheatgrass, vine-mesquite, and tall dropseed. Little bluestem, sand bluestem, and other tall grasses grow in some areas that have above-average moisture. About 40 percent of the climax vegetation consists of buffalograss, silver bluestem, meadow dropseed, and other increasers. Continuous overgrazing causes Texas grama, hairy tridens, sand dropseed, many annual grasses, pricklypear, and mesquite to invade.

LOAMY PRAIRIE

This site consists of nearly level to rolling soils that have a surface layer, mainly of loam, silt loam, or very fine sandy loam. The texture and depth are such that the soils take in water readily and store it. They are therefore suited to little bluestem, sand bluestem, and other tall grasses that make good yields of forage. The following soils and the areas indicated in the two complexes are in this site:

Chickasha loam, 0 to 1 percent slopes.
Enterprise very fine sandy loam, 0 to 1 percent slopes.
Enterprise very fine sandy loam, 1 to 3 percent slopes.
Enterprise very fine sandy loam, 3 to 5 percent slopes.
Enterprise very fine sandy loam, 5 to 8 percent slopes.
Lawton loam, 0 to 1 percent slopes.
Lawton loam, 1 to 3 percent slopes.
Lawton loam, 3 to 5 percent slopes.
Lawton loam, 3 to 5 percent slopes, eroded.
Lucien-Zaneis-Vernon complex (Lucien-Zaneis portion).
Tipton loam, 0 to 1 percent slopes.
Tipton loam, 1 to 3 percent slopes.
Zaneis loam, 1 to 3 percent slopes.
Zaneis loam, 3 to 5 percent slopes.
Zaneis loam, 3 to 5 percent slopes, eroded.
Zaneis soils, severely eroded.
Zaneis-slickspot complex, 1 to 3 percent slopes (Zaneis portion).

This is the most productive range site in the uplands (fig. 20). Approximately 75 percent of the climax vegetation consists of decreaser grasses, such as little bluestem, switchgrass, sand bluestem, Indiangrass, and big bluestem. About 10 percent of the climax vegetation is legumes, other forbs, and woody plants, and about 15 percent consists of side-oats grama, blue grama, hairy grama, buffalograss, and other increasers.

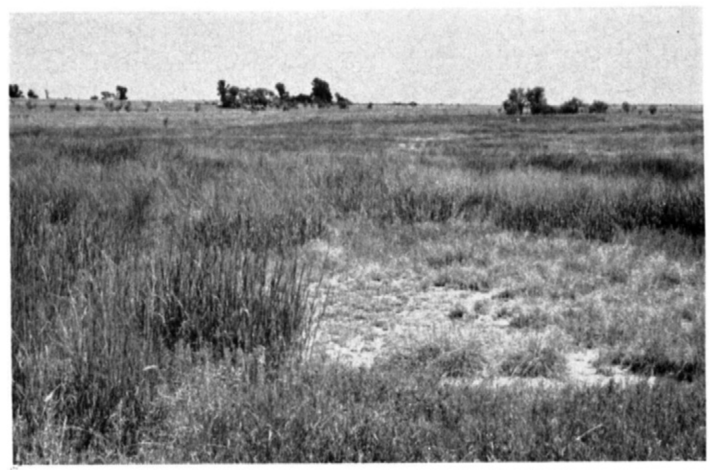

Figure 20.—**Loamy Prairie and Slickspot range sites in excellent condition. The Loamy Prairie site on the left supports switchgrass and sand bluestem. The Slickspot site at right center supports alkali sacaton and whorled dropseed. The area at the lower right consists of soils that are between those of the Loamy Prairie and the Slickspot sites, and it supports blue grama, side-oats grama, and western ragweed.**

Overuse will cause openings in the ground cover and permit the invasion of annual three-awn, Japanese brome, little barley, annual broomweed, western ragweed, and other weedy grasses and forbs. In places mesquite also invades the site. Light to moderate use generally results in the return of climax vegetation. Deferred grazing during the growing season normally brings about more rapid improvement. The normal grazing season extends from late in spring through the summer, but grazing may continue throughout the year.

RED CLAY FLATS

Only one mapping unit—Treadway soils—is in this site. The soils are nearly level and are on alluvial fans that lie below outcrops of Vernon clay and shale. The surface layer of the Treadway soils is clay or clay loam except for some areas where windblown soil material has accumulated. The clay material is very low in organic matter. These soils form a hard crust on their surface that is almost impervious to water, air, and roots. In areas where these soils have not been improved, there are generally bare areas on deposits of recent outwash.

The productivity of these soils is variable, but it is generally low. A tall, yellow-flowered forb called rhombopod is normally the first plant to become established on

these areas, and other low-order forbs and grasses follow in time. Buffalograss, vine-mesquite, side-oats grama, blue grama, inland saltgrass, and Texas grama are some of the grasses that grow on this site. In places the areas that have deep deposits of material blown from the Red River support a growth of switchgrass and other tall and mid grasses. Mesquite has invaded most of these areas (fig. 21).

Figure 21.—**Red Clay Flats range site where mesquite has invaded. The grasses on this site are blue grama, meadow dropseed, silver bluestem, and buffalograss. Vine-mesquite is growing along the fence, where it is protected from grazing. The hills in the background are in the Red Clay Prairie range site.**

ERODED CLAY

Only one mapping unit—Eroded clayey land—is in this site. The vegetation that can normally be established on this site is about the same as that for the Hardland site. The yields of forage are generally lower than those on the Hardland site because much of the water is lost and the soil material is low in fertility. Deferred grazing throughout the summer may be required to protect the areas from erosion.

SANDY BOTTOM LAND

Only one mapping unit—Lincoln soils—is in this site. It consists of sandy soils on the bottom lands along the Red River. The soils have a sandy texture that allows them to take in moisture rapidly, but in some areas where the sand is deep, they tend to be droughty. Some fairly small areas are subirrigated and have the potential for high production of forage. In some places the production is limited by overflow from the river and by sediments deposited during overflow.

The climax vegetation is about 80 percent switchgrass, sand bluestem, Indiangrass, little bluestem, and other decreaser plants. About 20 percent consists of sand lovegrass, fringeleaf paspalum, Scribner panicum, and other increasers. Woody increasers are cottonwood, willow, saltcedar, and associated species. Bermudagrass is commonly carried in by floodwaters and has become established in some areas. Other common invaders are mat sandbur, sand dropseed, bullnettle, snakecotton, camphorweed, annual wild buckwheat, and pricklepoppy.

SLICKSPOT

The Slickspot site consists of areas of a slickspot soil of the uplands that has a hard, alkali crust. It is surrounded by areas of soils that are in the Hardland and Loamy Prairie range sites. The concentration of salts and the subsoil of compact clay in the slickspot soil limit the vegetation to plants that tolerate salt and that resist drought. The slickspot areas in the following soil complexes are in this range site:

Foard-slickspot complex, 0 to 1 percent slopes (slickspot portion).
Foard-slickspot complex, 1 to 3 percent slopes (slickspot portion).
Zaneis-slickspot complex, 1 to 3 percent slopes (slickspot portion).

This site is very low in productivity. The dominant vegetation varies according to the severity of the effect of the alkali. In places the most severely affected areas have no vegetation. Progressively, rhombopod, whorled dropseed, alkali sacaton, tumblegrass, Texas wintergrass, Texas grama, and blue grama will grow as the severity of the effect of the alkali decreases.

RED CLAY PRAIRIE

The soils in this site are gently sloping to rolling and contain a large amount of clay. Therefore, they take in moisture slowly. In addition, they are slow to release the moisture to the roots of plants. They are not suited to tall grasses. The following soils and the areas indicated in the two complexes are in this site:

Breaks-alluvial land complex (Breaks portion).
Lucien-Zaneis-Vernon complex (Vernon portion).
Vernon clay, 1 to 3 percent slopes.
Vernon soils, 3 to 5 percent slopes.
Vernon soils, 5 to 12 percent slopes.

Approximately 50 percent of the climax vegetation on this site consists of decreasers, such as little bluestem, sand bluestem, western wheatgrass, switchgrass, tall dropseed, side-oats grama, and vine-mesquite. The rest is mainly blue grama, hairy grama, buffalograss, and other increasers.

As the climax vegetation declines, annual three-awn, Japanese brome, little barley, red three-awn, Texas grama, and other weedy grasses and forbs invade this site. Pricklypear and mesquite often invade as the result of overuse.

To improve the vegetation, grazing should be deferred during the growing season. Recovery is usually slow because the soils are droughty.

LOAMY BOTTOM LAND

This site is made up of nearly level, alluvial soils on the flood plains of the larger streams in the county. The soils are fertile and very productive. They are moderately permeable and have a moderate to high water-holding capacity. Therefore, trees, as well as grasses and forbs, grow well. Most of the acreage has been cleared for cultivation. Some of the areas that once were cleared, however, are now used for tame pasture consisting mostly of bermudagrass. The following soils and the areas indicated in the two complexes are in this site:

Breaks-alluvial land complex (Alluvial land portion).
Broken alluvial land.
Port clay loam.
Port loam.
Port-slickspot complex (Port portion).
Yahola fine sandy loam.

The climax vegetation includes tall and mid grasses, such as eastern gamagrass, big bluestem, sand bluestem,

Indiangrass, switchgrass, Canada wildrye, and Virginia wildrye. The forbs in the climax vegetation consist of perennial sunflower, compassplant, perennial lespedeza, and tickclover. The trees on this site are pecan, elm, oak, hackberry, and cottonwood.

Woody plants have developed dense stands on some areas where heavy grazing has reduced the vigor and density of the productive grasses. Other areas have deteriorated and are covered by less palatable and less productive grasses, such as silver bluestem, meadow dropseed, Texas wintergrass, and buffalograss. Productivity can be restored by controlling the brush and grazing the areas properly.

HEAVY BOTTOM LAND

Only one mapping unit—Miller clay—is in this site. It is a clayey soil of the bottom lands, and part of the acreage is subject to frequent flooding. Most of the acreage is cultivated, and some is used for tame pasture.

A large part of the climax vegetation on this site consists of grasses that grow in cool seasons, mainly Virginia wildrye. Other grasses are switchgrass, Indiangrass, sand bluestem, big bluestem, eastern gamagrass, buffalograss, and little bluestem. Sedges are also common. Nearly pure stands of one kind of plant grow where the combination of soil structure and supply of available moisture are particularly suited to the plant. Sumpweed generally grows in very poorly drained areas. Trees and brush grow in some areas, especially where flooding is most frequent.

Grazing abuse causes the productive tall grasses to give way to plants that are not grazed because they are not palatable or because they grow too near the surface of the ground. These plants include buffalograss, sumpweed, meadow dropseed, silver bluestem, western ragweed, Texas wintergrass, and windmillgrass.

BREAKS

Only one mapping unit—Rough broken land—is in this site. It consists of bluffs and escarpments and is nearly level to steeply sloping. The steep slopes restrict livestock travel. Most of the soil material is red clay and shaly clay, and there are many bare areas.

The yields of forage are low on this site because of the large areas of shallow and bare soil material. The vegetation varies greatly. Tall grasses, such as sand bluestem, generally grow in pockets of deep soil material. Blue grama, hairy grama, and side-oats grama normally grow on the areas where the soil material is shallow. Annuals that grow in cool seasons are common in areas that would otherwise be bare. Mesquite is invading some areas.

DEEP SAND

This site is made up of deep, sandy soils. These soils absorb moisture well; therefore, they are suited to the highest producing grasses and to a few woody plants. The water-holding capacity, however, is limited; consequently, the vegetation is damaged because moisture is lacking during periods of drought. The topography ranges from gently sloping to steeply sloping and includes some sand dunes near the Red River. The following soils are in this site:

Pratt loamy fine sand, undulating.
Pratt and Tivoli soils, rolling.
Shellabarger loamy sand, 0 to 4 percent slopes.

The yields of forage on these soils fluctuate greatly according to the amount of rainfall. The climax vegetation is little bluestem, sand bluestem, switchgrass, Indiangrass, sand lovegrass, big sandreed, and sand dropseed. Sand sage and yucca are common on local areas. There are a few scrubby trees, mostly hackberry. Sand-lily, pricklepoppy, and bullnettle are indicators of this site. Heavy grazing decreases the tall grasses and increases sand dropseed and annuals, such as sandgrass and annual wild buckwheat.

Practices for rangeland

Practices applicable on rangeland are proper grazing use, deferred grazing, development of watering places, seeding range plants, and controlling weeds and brush.

Proper grazing use.—Grazing range at an intensity that maintains cover adequate to protect the soil and that maintains or improves the quality and the quantity of the desirable vegetation is the most important of all range practices. As a general rule, proper grazing means grazing not more than one-half of the annual growth of the main decreaser plants in the range site.

Within each pasture, the operator can select key sites and key forage plants on which to base his decisions on proper grazing use. For example, a pasture might contain three range sites: Loamy Prairie, Red Clay Prairie, and Hardland. If the Loamy Prairie site represents the most important forage-producing area in the pasture, it is normally the key site for management. If the most abundant kind of grass present on the site is little bluestem, then little bluestem is the key forage plant. When one-half of the current year's growth of this grass is removed from the Loamy Prairie site, then the site has been grazed properly. If one-half of the grass is removed before the end of the planned grazing period, the livestock should be removed.

Deferred grazing.—Periodically postponing, or deferring grazing for a prescribed time during any period of plant growth helps to improve the range. Maximum range improvement can be expected in areas where grazing is deferred during the entire growing season. Deferment in spring generally increases the vigor and productivity of range grasses that grow in warm seasons. Deferment in fall generally increases the production of seed. Deferring grazing after the weeds and brush have been controlled is far more effective than deferring it before the weeds and brush have been controlled. Deferred grazing is especially important on soils that are eroded, such as Eroded clayey land, in the Eroded Clay range site, or on soils that are highly susceptible to erosion.

Development of water.—Water for livestock is generally provided by building ponds. Wells may be needed, however, in deep, sandy sites. Water facilities for livestock should be located to encourage proper grazing use.

Seeding range plants.—Seeding suitable grasses and legumes, primarily native plants, is an important range practice. The climax range plants listed in the descriptions of the range sites give the most satisfactory results for the different sites. Satisfactory seedings can be made on either a clean-tilled seedbed or in a cover of sorghum on the Hardland, Heavy Bottom Land, Loamy Prairie, Loamy Bottom Land, Slickspot, and Red Clay Prairie

range sites. Seedings are more dependable on other sites when made in a cover of sorghum. Where sorghum is difficult to establish, grass can be seeded in a cover of weeds, which provides sufficient protection from blowing.

Control of brush.—The main type of brush in Cotton County is mesquite. Mesquite trees have invaded many areas and will continue to spread unless measures are used to control them (fig. 22). Chemical control is apparently the most practical for large areas. Hand grubbing is satisfactory in areas where the trees are few and small. The greatest infestation is on the Hardland, Red Clay Flats, and Red Clay Prairie range sites. The low productivity of the Red Clay Flats site may make control practices impractical.

***Figure 22.*—Mesquite trees that have been killed by pouring kerosene on the crowns.**

Control of weeds.—Normally, weeds can be controlled through proper grazing use, deferred grazing, and other management practices. Where perennial weeds are severely competing with the grass, however, it may pay to spray with a chemical to speed up the recovery of the range.

Estimated yields of forage

Research and other data on actual range production for the soils and range sites in the county are limited. So that the operator can gain a better understanding of the relative productivity of his range sites, table 4 shows the estimated annual yields of forage on the range sites in Cotton County. The estimates represent both favorable and unfavorable climatic cycles and are for range sites in excellent condition. One or two extremely favorable years in a series of years where climatic conditions have been good might push the yields higher. Likewise, extreme drought could result in lower annual yields than are shown for the unfavorable periods. These estimated yields are based on total air-dried forage clipped to ground level.

Normally, in considering actual usable forage or mowed hay, the amount will be considerably less than it appears. If the operator manages grazing to leave one-half of the annual growth, the animals may not actually consume one-half of the forage produced. This is because of natural losses by rodents, insects, weathering, and other causes. When one-half of the forage remains, the animal may have actually consumed only from 25 to 35 percent of the growth for the current season.

TABLE 4.—*Estimated average acre yields of forage representative of favorable and unfavorable climatic cycles*

Range site	Total yields of forage in years of—	
	Favorable climate	Unfavorable climate
	Lb. per acre	*Lb. per acre*
Alkali Bottom Land	3, 000	1, 200
Hardland	2, 900	1, 500
Loamy Prairie	4, 200	1, 800
Red Clay Flats	1, 000	400
Eroded Clay	600	200
Sandy Bottom Land	3, 000	1, 800
Slickspot	1, 800	800
Red Clay Prairie	2, 200	1, 000
Loamy Bottom Land	5, 500	2, 000
Heavy Bottom Land	4, 500	2, 000
Breaks	1, 800	1, 200
Deep Sand	3, 500	1, 400

Woodland and Windbreaks [5]

Trees are native in Cotton County only on the bottom lands along streams and in areas that extend varying distances up tributaries that are normally dry. The areas around Beaver and Little Beaver, Cache, and West Cache, Deep Red, Whiskey, and Rabbit Creeks have, in the past, furnished much rough lumber and posts for local use. There are still some trees that are suitable for lumber or posts, and one sawmill operates at intervals. Among the principal kinds of trees are elm, hackberry, ash, cottonwood, willow, and soapberry. Pecan trees are plentiful, and there is a ready market for the nuts.

Table 5 indicates the suitability of the soils in the county for windbreaks and post lots. At present, only minor interest is shown in planting windbreaks and post lots, although they should be successful on the nearly level and gently sloping Enterprise soils and on the Chickasha, Tipton, and Yahola soils. The moderately sloping and steeply sloping Enterprise soils are rated "suitable with limitations" because these soils have limited depth and are in a position that requires extra water for good growth of trees. If properly planted and cared for, field windbreaks would help to control erosion on areas of Enterprise and Tipton soils. The plantings for windbreaks and post lots would also contribute greatly needed food and cover for wildlife.

To be of maximum benefit for windbreaks, the trees need to be planted in a series. The interval between belts should be no more than 20 times the anticipated height of the tallest trees. The planting pattern ought to consist of belts that extend from east to west and of other belts that extend from north to south.

[5] By HERBERT R. WELLS, Soil Conservation Service.

676-152—63——4

TABLE 5.—*Suitability of soils for windbreaks and post lots* [1]

Soil	Suitability for— Windbreaks	Suitability for— Post lots
Breaks-alluvial land complex	Not suitable	Not suitable.
Broken alluvial land	Suitable	Suitable.
Chickasha loam, 0 to 1 percent slopes.	Suitable	Suitable.
Enterprise very fine sandy loam, 0 to 1 percent slopes.	Suitable	Suitable.
Enterprise very fine sandy loam, 1 to 3 percent slopes.	Suitable	Suitable.
Enterprise very fine sandy loam, 3 to 5 percent slopes.	Suitable with limitations.	Suitable with limitations.
Enterprise very fine sandy loam, 5 to 8 percent slopes.	Suitable with limitations.	Suitable with limitations.
Eroded clayey land	Not suitable	Not suitable.
Foard silt loam, 0 to 1 percent slopes.	Suitable with limitations.	Not suitable.
Foard-slickspot complex, 0 to 1 percent slopes.	Not suitable	Not suitable.
Foard-slickspot complex, 1 to 3 percent slopes.	Not suitable	Not suitable.
Foard and Tillman silt loams, 1 to 3 percent slopes.	Suitable with limitations.	Not suitable.
Lawton loam, 0 to 1 percent slopes.	Suitable	Suitable.
Lawton loam, 1 to 3 percent slopes.	Suitable	Suitable.
Lawton loam, 3 to 5 percent slopes.	Suitable with limitations.	Not suitable.
Lawton loam, 3 to 5 percent slopes, eroded.	Suitable with limitations.	Not suitable.
Lincoln soils	Suitable	Suitable.
Lucien-Zaneis-Vernon complex	Not suitable	Not suitable.
Miller clay	Suitable with limitations.	Not suitable.
Port clay loam	Suitable	Suitable.
Port loam	Suitable	Suitable.
Port-slickspot complex	Not suitable	Not Suitable.
Pratt loamy fine sand, undulating	Suitable	Suitable with limitations.
Pratt and Tivoli soils, rolling	Suitable with limitations.	Not suitable.
Rough broken land	Not suitable	Not suitable.
Shellabarger loamy sand, 0 to 4 percent slopes.	Suitable with limitations.	Not suitable.
Tillman silt loam, 1 to 3 percent slopes.	Suitable with limitations.	Not suitable.
Tipton loam, 0 to 1 percent slopes	Suitable	Suitable.
Tipton loam, 1 to 3 percent slopes	Suitable	Suitable.
Treadway soils	Not suitable	Not suitable.
Vernon clay, 1 to 3 percent slopes	Not suitable	Not suitable.
Vernon soils, 3 to 5 percent slopes	Not suitable	Not suitable.
Vernon soils, 5 to 12 percent slopes	Not suitable	Not suitable.
Waurika silt loam	Suitable with limitations.	Not suitable.
Yahola fine sandy loam	Suitable	Suitable.
Zaneis loam, 1 to 3 percent slopes	Suitable	Suitable.
Zaneis loam, 3 to 5 percent slopes	Suitable with limitations.	Not suitable.
Zaneis loam, 3 to 5 percent slopes, eroded.	Suitable with limitations.	Not suitable.
Zaneis soils, severely eroded	Not suitable	Not suitable.
Zaneis-slickspot complex, 1 to 3 percent slopes.	Not suitable	Not suitable.

[1] A rating described as "suitable with limitations" indicates that the soil has unfavorable profile characteristics, limited depth, or is in a position that requires extra water, extra tillage, or wide spacing.

Farmstead windbreaks can be established on a number of different soils throughout the county. They can be established on some of the soils that are poor for trees because the trees do not need to be so tall as those in field windbreaks. In addition, supplemental water from the farmyard can be used for the trees in farmstead windbreaks during severe drought. To be effective, the farmstead windbreak should be L-shaped or planted on the contour, thereby protecting at least two sides of the farmstead.

As a rule, two rows of tall trees and one row of shrubs are considered the minimum for a good windbreak. Suitable trees and shrubs that are readily available for both field windbreaks and farmstead windbreaks are Chinese elm, cottonwood, sycamore, Russian mulberry, vitex, redcedar, arborvitae, and Austrian, shortleaf, and loblolly pines. In addition to the vitex for the shrub row, Russian mulberry and redcedar or arborvitae may be used in the shrub row with the taller trees. The trees must be cultivated until the crowns are nearly closed over the space between the rows. The plantings must be protected from livestock and fire.

Small post lots on the Tipton and Enterprise soils and on some soils of the bottom lands would produce enough posts for one to several farms. Their planting and management are the same as that for windbreaks except that after the trees are cut the sprouts should be pruned and reduced to one or two per stump. Species suggested for all sites are black locust and bois-d'arc. Catalpa should be grown only on areas of bottom land.

Wildlife

In pioneer times the settlers in the area that is now Cotton County hunted and fished to obtain food for their immediate use. The exploitation of wildlife continued long after the supply of domestic animals was adequate. We are now, however, beginning to realize the value of wildlife.

Some kinds of wildlife are valuable for controlling insects and rodents. Birds, hawks, owls, and insect-eating animals, such as skunks, moles, and armadillos, naturally belong on the land. Many different kinds of wildlife can live on a farm or ranch if food, cover, and water are present.

Species of game birds and animals common to Cotton County are bobwhite quail, dove, waterfowl, and fox squirrel. Cottontail rabbits and jackrabbits are also present. Wild turkey has been introduced, with some promise of success, just north of the Red River and east of the lower Cache Creek. Whitetail deer were very recently released in the same area. Birds of the uplands include the meadowlark, field sparrow, robin, blackbird, mourning dove, and other birds that eat insects.

Throughout the county, the population of wildlife is fairly small. The three major drainage systems—Beaver, Cache, and Deep Red Run Creeks—however, still provide a good natural habitat, and wildlife is plentiful in those areas. Interrupted areas that provide a good natural habitat occur also along the Red River. These areas compensate partly for the generally sparse population in

the uplands. Except for some areas of invading mesquite and of ornamental plantings, the uplands are almost devoid of trees and shrubs. The choice and intensity of the practices used to grow crops and to raise livestock are the major determinants of the population of wildlife throughout the county.

A general plan for developing and improving wildlife habitats includes some of the following minimum practices. Protect existing natural habitats and plantings from overuse by livestock and from uncontrolled fire. Plant shrubs and trees to provide food and cover. Give particular attention to planting in and around gullies, around ponds, and along streambanks and windbreaks. Where the terrain permits, prepare the site in advance of planting and cultivate the shrubs and trees. Planting and cultivation should be on the contour. Develop a complete conservation plan to provide food, cover, and water for wildlife throughout the year.

Much can be done to improve conditions for wildlife in fringe areas and at intervals along the drainageways. Good practices include proper grazing or excluding livestock, installing and maintaining basins in the beds of intermittent streams, and establishing travel lanes near areas where planting has been done to provide food and cover.

Over much of the uplands, it would be a major and expensive task to develop adequate food and cover for any worthwhile number of wildlife. Locally, however, there are good opportunities on the soils in the Loamy Prairie range site east of Cache Creek and on the Yahola, Enterprise, and Tipton soils bordering the Red River. These soils are suited to switchgrass, Indiangrass, and bluestem rather than to the short and mid grasses of the Hardland site that extends westward from Cache Creek. Plantings of species suitable for wildlife would also be successful on a number of the soils. Generally, management practices are the same as those used along drainageways, but additional emphasis is placed on the development of marginal cover around fields to serve as travel lanes.

Of the 2,400 farm ponds in the county, about 30 percent have satisfactory depth and water characteristics for the production of fish and for brief periods of use by wildfowl. There are three lakes, ranging in size from 40 to 70 surface acres, that are managed to some degree for the production of fish. Except for the lower part of Cache Creek and some pools upstream that retain influxes of fish from the Red River, the streams in the county can be used for fishing only during periods of high water. The lakes and ponds are stocked mainly with largemouth bass, bluegill, red-ear, and channel catfish. With proper management, good production can be achieved. The most common stream fish are channel and flathead catfish, carp, and several species of sunfish.

The furbearers in the county are mainly skunk, opossum, raccoon, mink, and coyote. These animals are not numerous, and the amount of fur marketed is negligible. Most of the coyotes are taken with hounds for sport.

Technical assistance in developing habitats and in stocking reservoirs can be obtained from the local Soil Conservation Service technician, the Soil Conservation District, the Oklahoma Department of Wildlife Conservation, the United States Fish and Wildlife Service, the State or Federal forester, or the county agent.

Engineering Uses of the Soils [6]

Some soil properties are of special interest to engineers because they affect the construction and maintenance of roads, airports, pipelines, building foundations, facilities for water storage, erosion control structures, drainage systems, and sewage disposal systems. The properties most important to the engineer are permeability to water, shear strength, consolidation characteristics, texture, plasticity, and reaction. Depth of unconsolidated material and topography are also important.

The information in this report can be used by engineers to—

1. Make soil and land use studies that will aid in selecting and developing industrial, business, residential, and recreational sites.
2. Make preliminary estimates of the engineering properties of soils that will help in planning agricultural drainage systems, farm ponds, irrigation systems, terraces, and waterways.
3. Make preliminary evaluations of soil and ground conditions that will aid in selecting highway and airport locations and in planning detailed investigations of selected locations.
4. Locate probable sources of gravel, sand, and other construction materials.
5. Correlate performance of engineering structures with soil mapping units, and thus develop information that will be useful in designing and maintaining the structures.
6. Determine the suitability of soils for cross-country movement of vehicles and construction equipment.
7. Supplement information obtained from other published maps, reports, and aerial photographs for the purpose of making maps and reports that will be more useful to engineers.
8. Develop other preliminary estimates for construction purposes that are pertinent to the particular area.

It is not intended that this report will eliminate the need for on-site sampling and testing for design and construction of specific engineering works or for other uses. The report should be used primarily in planning more detailed field investigations to determine the condition of the soil in place at the proposed site of construction.

Some of the terms used by the agricultural soil scientist may be unfamiliar to the engineer, and other terms may have a special meaning in soil science. These terms are defined in the Glossary at the end of the report.

Engineering classification systems

Agricultural scientists of the United States Department of Agriculture classify soils according to texture. In some ways this system of naming textural classes is comparable to the two systems used by engineers for classifying soils, that is, the system of the American Association of State Highway Officials (AASHO) and the Unified sys-

[6] Prepared with the assistance of HARRY A. ELAM and BOB G. DAY, agricultural engineers, Soil Conservation Service.

tem. The systems used by engineers are explained briefly in the following paragraphs. The explanations are taken largely from the PCA Primer (*7*).[7]

The AASHO system groups the soils according to their engineering properties, based on field performance of highways (*1*). In this system soil materials are classified in seven basic groups, designated as A–1 through A–7. The best soils for road subgrade—gravelly soils of high bearing capacity—are classified as A–1, the next best, A–2, and so on to the poorest, which are classified as A–7. Within each group, the relative engineering value of the soil material is indicated by a group index number. The range for the group index number is from 0 for the best material to 20 for the poorest. The group index is shown in parentheses after the soil group symbol in table 8.

In the Unified system the soils are grouped on the basis of their texture and plasticity and their performance as material for engineering structures (*8*). The soil materials are identified as course grained, which are gravels (G) and sands (S); fine grained, which are silts (M) and clays (C); and highly organic (Pt). In this system clean sands are identified by the symbols SW or SP; sands with fines of silt and clay are identified by the symbols SM and SC; silts and clays that have a low liquid limit are identified by the symbols ML and CL; and silts and clays that have a high liquid limit are identified by the symbols MH and CH.

Engineering interpretations of the soils

The engineer should know the properties of the soils that affect their use for engineering purposes and the in-place condition of the soils at the site where construction is planned. This knowledge will help him make the best use of the soil map and the soil survey report.

Table 6 gives a brief description of all the soils mapped in Cotton County. It also gives the textural classification of the U.S. Department of Agriculture, estimates of the classification used by the American Association of State Highway Officials, and estimates of the Unified classification. In addition, the grain size, permeability, available water capacity, reaction, and shrink-swell potential are estimated and the hydrologic soil group is given. In this table the description of the soil properties is based on a single typical profile for each soil mapped. The soil profile is divided into layers significant in engineering, according to the depth, in inches, from the surface. Where test data are available, the estimates shown are based on the test data obtained for the modal or typical profiles. Where tests were not performed, the estimates shown are based on test data obtained from similar soils in this county and by past experience in engineering construction. Because the estimates are only for the modal soils, considerable variation from these values should be anticipated. A more complete description of each profile may be found in the section "Formation, Morphology, and Classification of Soils."

In the column showing permeability, the rate at which moisture moves downward in the undisturbed soil is estimated; the rate is expressed in inches per hour.

Available water capacity, described in inches per inch of soil depth, refers to the approximate amount of capillary water in the soil when the soil is wet to field capacity. When the soil is air dry, the amount of water indicated will wet the soil material described to a depth of 1 inch without deeper percolation.

[7] Italic numbers in parentheses refer to Literature Cited, p. 69.

The column showing reaction indicates the estimated acidity or alkalinity of the soils.

The shrink-swell potential is an indication of the volume change to be expected with changes in content of moisture. In general, soils classified as CH and A–7 have a high shrink-swell potential. Clean sands and gravels (single grain) and those having small amounts of nonplastic to slightly plastic fines, as well as most other nonplastic to slightly plastic soil materials, have a low shrink-swell potential.

The soils of the county were placed in four hydrologic soil groups according to groupings given in the Soil Conservation Service Engineering Handbook, Supplement A, section 4. These hydrologic groups are based on the ability of the soils to absorb water and are used to estimate runoff. The soils in group A are deep sands that soak up most of the water from rainfall and lose the least amount of water through runoff. The soils in group D are mostly clays that have a low rate of infiltration. They absorb less water than any of the soils, and they lose the most water through runoff.

Table 7 shows specific characteristics of the soils that affect their use for engineering purposes. These characteristics may affect the selection of a site, and they may affect the design of a structure or the application of measures to make the soils suitable for construction. The data in this table are based on estimated data given in table 6, on actual test data given in table 8, on field experience, and on the observed performance of the soils. The rating terms *good*, *fair*, or *poor* are used to indicate suitability as a source of topsoil or road fill, and some of the soils are described as unsuitable. The suitability of the soil material for road fill depends largely on the texture of the material and on its natural content of water. Highly plastic soil materials that contain a large amount of natural water are rated as poor. Highly erodible soils, such as silts and fine sands, are difficult to compact, and they require moderately gentle slopes and fast vegetation coverage. They are, therefore, rated as fair. Soil features that affect engineering practices are also indicated in table 7.

A major construction problem is encountered in areas where a slickspot soil occurs in a complex pattern with the Foard, Zaneis, or Port soils. A slickspot soil is highly dispersed and is not stable when used in earthen structures. The deflocculation of the colloidal, or very fine, soil materials causes these soils to slide and erode easily and to be subject to piping and excessive settling. A detailed investigation of the soils at the site is needed where there is a chance that an area of dispersed soil exists.

Another construction problem occurs in the Vernon soils, which are shallow over clays of the red beds. Fills in these soils are subject to sheet and rill erosion. If vegetation is to be established on the Vernon soils, place a layer of topsoil at least 6 inches thick over the fill.

Table 8 gives a summary of test data made on a typical profile of several soils in the county. The modal profile of a series is the one most typical for the soil as it occurs in the county. A nonmodal profile is one that shows significant variations within the concept of the series or of

the mapping unit. The data furnished in this table are the results of tests made by the State of Oklahoma Department of Highways, Materials and Research Departments, in accordance with standard procedures of the American Association of State Highway Officials. For each soil listed, samples were taken from the A, B, and C horizons at a site considered typical for the particular soil. The depth, or thickness, of each horizon is shown in inches in the column that shows depth from surface.

The tests for liquid limit and plastic limit measure the effect of water on the consistence of the soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a semisolid to a plastic state. As the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material changes from a semisolid to a plastic state. The liquid limit is the moisture content at which the material changes from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is in a plastic condition.

As moisture leaves a soil, the soil shrinks and decreases in volume in proportion to the loss in moisture until a condition of equilibrium is reached. At that point shrinkage stops, although additional moisture is removed. The moisture content where shrinkage stops is called the shrinkage limit of the soil and is reported as the moisture content in relation to ovendry weight of the soil at the time when shrinkage stops.

Because clay is the major soil fraction that causes shrinkage, the shrinkage limit of a soil is a general index of the content of clay and will, in general, be a low number for soils that contain a great deal of clay. The shrinkage limit of clays, for example, ranges from about 6 to 14. The shrinkage limit of a sand that contains little or no clay, on the other hand, is close to the liquid limit and is considered insignificant. Sands containing some silt and clay have a shrinkage limit of about 14 to 25. The load-carrying capacity of a soil is at a maximum when the moisture content is at or below the shrinkage limit. Sands do not follow this rule, because they have a uniform load-carrying capacity within a wide range of moisture content, providing they are confined.

The shrinkage ratio of a soil is the volume change resulting from drying of the soil material, divided by the loss of moisture caused by drying. The ratio is expressed numerically. Theoretically, it is also the apparent specific gravity of the dried soil pat.

Volume change from field moisture equivalent (FME) is defined as the volume change, expressed as a percentage of the dry volume of the soil mass, when the moisture content is reduced from the FME to the shrinkage limit. The FME is the minimum content of moisture at which a smooth surface of an undisturbed soil will absorb no more water when the water is added in individual drops over a period of 30 seconds. It is the moisture content required to fill all the pores in sands and to approach saturation in cohesive soils that have not been disturbed.

The engineering soil classifications given in table 8 are based on data obtained by mechanical analysis and by tests to determine liquid limits and plastic limits. Mechanical analysis was made by combined sieve and hydrometer methods. Percentages of clay, obtained in this test by the hydrometer, are not suitable for determining U.S. Department of Agriculture textural classes of soils.

Formation, Morphology, and Classification of Soils

In the first part of this section, factors of soil formation and their relation to the soils of the county are discussed. In the second part the natural system of soil classification is explained and the soil series of the county are placed in great soil groups. The third part contains a short description of each great soil group in the county and a description of the soil series that are in each group.

Factors of Soil Formation

Soils are mixtures of fragmented and partly weathered rocks and minerals with organic matter, water, and air. The proportions vary in the different soils. The major factors that interact to form soils are parent material, climate, plant and animal life (particularly plant life), topography, and time. The characteristics of a soil at any given place have been determined by these five factors.

Parent material

The wide differences in kinds of parent material have resulted in correspondingly wide differences in the characteristics of some of the soils. On the uplands most of the soils formed in material weathered from medium-hard sandstone, siltstone, and slightly compacted, red clay. Some soils on the uplands formed in materials deposited by wind. In places on the flood plains and terraces, loose sands and friable sandy loams, clay loams, and silty clays have been blown or washed over the older deposits of alluvium.

The surface geologic materials of Cotton County belong to three geologic systems. The systems are the Permian, Quaternary, and Recent.

Permian.—The surface area of the county is underlain by Permian rocks. These materials were deposited in seas and are commonly referred to as Permian red beds.

The Wichita formation of this system covers about three-fourths of the county. This formation is 800 to 900 feet or more thick in most places. Most of the rocks that comprise this formation are red, maroon, and green clay shales and silty shales that contain thin lenses of soft, maroon sandstone. The main soils that formed in residuum from this material are members of the Chickasha, Lucien, Zaneis, Foard, Tillman, and Vernon series.

Quaternary.—The Quaternary deposits in the county are on the second bottoms of streams and on the old, high terraces along the Red River. These materials were laid down chiefly during Pleistocene time. They are loose, loamy and sandy materials as much as 50 feet thick over the Permian rocks. The loamy deposits are mostly smooth and consist of old alluvium with or without a mantle of loess. The sandy deposits are smooth to undulating and have a surface that consists of scattered dunes. These materials are mainly old alluvium that has been greatly modified and shifted by wind.

TABLE 6.—*Brief description of the soils and*

Map symbol	Soil	Description of soil and site	Depth from surface
			Inches
Ba	Breaks-alluvial land complex.	Composed mainly of Foard, Tillman, Vernon, and Port soils along small tributaries where there are short, steep side slopes and narrow areas of bottom lands; the slopes are variable; see descriptions of Foard, Tillman, Vernon, and Port soils.	------------
Bd	Broken alluvial land.	Mainly nearly level Port clay loams and Port loams on narrow flood plains; subject to frequent flooding; see descriptions of Port clay loam and Port loam.	------------
ChA	Chickasha loam, 0 to 1 percent slopes.	Deep, nearly level, well-drained soil of the uplands; formed over weathered sandstone, which is at a depth of 4 to 7 feet.	0 to 12 12 to 33 33 to 60
ErA ErB ErC ErD	Enterprise very fine sandy loam, 0 to 1 percent slopes. Enterprise very fine sandy loam, 1 to 3 percent slopes. Enterprise very fine sandy loam, 3 to 5 percent slopes. Enterprise very fine sandy loam, 5 to 8 percent slopes.	Deep, well-drained soils of the uplands; formed in wind-deposited sands and silts; underlain by clay of the red beds, at a depth of 6 to 12 feet or more.	0 to 56
Es	Eroded clayey land.	Consists mainly of severely eroded Foard and Tillman soils but includes some areas of Vernon soils; slopes are 3 to 5 percent; see descriptions of Foard, Tillman, and Vernon soils.	------------
FoA	Foard silt loam, 0 to 1 percent slopes.	Deep, nearly level soil of the uplands; the subsoil is a heavy clay and overlies clay of the red beds at a depth of 5 to 8 feet.	0 to 9 9 to 29 29 to 66
FsA FsB	Foard-slickspot complex, 0 to 1 percent slopes. Foard-slickspot complex, 1 to 3 percent slopes.	Deep soils of the uplands and numerous areas of a highly dispersed slickspot soil, for which properties here are given; has a compact claypan in the subsoil.	0 to 6 6 to 29 29 to 66
FtB	Foard and Tillman silt loams, 1 to 3 percent slopes.	Deep soils of the uplands; the subsoil is a heavy clay; approximately 35 percent of the mapping unit is a Foard soil, and 65 percent is a Tillman soil; see descriptions of Foard silt loam and of Tillman silt loam.	------------
LaA LaB LaC LaC2	Lawton loam, 0 to 1 percent slopes. Lawton loam, 1 to 3 percent slopes. Lawton loam, 3 to 5 percent slopes. Lawton loam, 3 to 5 percent slopes, eroded.	Deep, well-drained, nearly level to moderately sloping soils of the uplands; formed in granitic outwash from the Wichita Mountains.	0 to 10 10 to 60 60 to 72
Ls	Lincoln soils.	Deep, sandy, alluvial soils on nearly level flood plains; subject to occasional flooding; very sandy subsoil; the water table is at a depth of 6 to 12 feet.	0 to 15 15 to 50+
Lz	Lucien-Zaneis-Vernon complex.	The Lucien soil, for which properties are here given, is shallow over soft sandstone and has steep slopes; see descriptions of the Zaneis and Vernon soils for the other members of the complex; the slopes are variable.	0 to 10 10+
Mr	Miller clay.	Deep, nearly level, clayey soil of the bottom lands; subject to occasional overflow.	0 to 86
Po	Port clay loam.	Deep, nearly level soil of the bottom lands; subject to occasional overflow.	0 to 60
Pr	Port loam.	Deep, nearly level soil of the bottom lands; subject to occasional overflow.	0 to 30 30 to 62 62 to 72
Ps	Port-slickspot complex.	Deep, nearly level soil of the bottom lands and numerous areas of a highly dispersed slickspot soil; subject to overflow. See descriptions of Port clay loam and Port loam for descriptions of the Port soils of this complex.	------------

their estimated physical and chemical properties

Classification			Percentage passing sieve—		Permeability	Available water capacity	Reaction	Shrink-swell potential	Hydrologic soil group
USDA texture	Unified	AASHO	No. 10	No. 200					
					Inches per hour	*Inches per inch*	*pH*		
Loam	ML	A-4	100	50 to 60	0. 8 to 2. 5	0. 14	5. 8 to 6. 3	Low	B
Clay loam	CL	A-6	100	55 to 65	0. 8 to 2. 5	. 14	6. 0 to 6. 5	Moderate	
Sandy clay loam	CL	A-6	100	55 to 65	0. 8 to 2. 5	. 14	6. 3 to 6. 7	Moderate	
Very fine sandy loam	ML	A-4	100	60 to 75	0. 8 to 2. 5	. 14	7. 0 to 7. 5	Low	B
Silt loam	CL-ML	A-4	100	80 to 90	0. 2 to 0. 8	. 16	6. 2 to 6. 7	Low	C
Clay	MH-CH	A-7	100	85 to 95	0. 05 to 0. 2	. 17	7. 7 to 8. 2	High	
Silty clay	CL-CH	A-7	100	85 to 95	0. 05 to 0. 2	. 17	7. 5 to 8. 5	High	
Clay loam	CL-ML	A-4	100	80 to 90	0. 05 to 0. 8	. 16	6. 2 to 6. 7	Low	C
Clay	CH	A-7	100	85 to 95	0. 05 to 0. 2	. 17	7. 7 to 8. 2	High	
Silty clay	CL	A-7	100	85 to 95	0. 05 to 0. 2	. 17	7. 5 to 8. 5	Moderate to high.	
Loam	ML-CL	A-4	100	60 to 70	0. 8 to 2. 5	. 14	6. 8 to 7. 3	Low	C
Clay loam	CL	A-6	100	65 to 75	0. 8 to 2. 5	. 13	6. 2 to 6. 7	Moderate to high.	
Clay loam	CL	A-6	100	60 to 70	0. 8 to 2. 5	. 13	7. 8 to 8. 3	Moderate	
Loamy fine sand	SM	A-2	100	20 to 35	2. 5 to 5. 0	. 07	7. 8 to 8. 3	Low	A
Fine sand	SP-SM	A-2	100	10 to 20	2. 5 to 10. 0	. 06	7. 8 to 8. 3	Low	
Very fine sandy loam	ML	A-4	100	50 to 60	0. 8 to 2. 5	. 14	6. 8 to 7. 3	Low	D
Soft sandstone	ML-CL	A-4	100	50 to 60	0. 05 to 0. 2	. 14	7. 3 to 7. 8	Low	
Clay	CL, CH	A-7	100	90 to 99	0. 05 to 0. 2	. 17	7. 8 to 8. 3	High	C
Clay loam	CL	A-6	100	55 to 90	0. 2 to 0. 8	. 17	7. 0 to 8. 0	Moderate to high.	C
Loam	CL	A-4	100	70 to 80	0. 8 to 2. 5	. 14	7. 3 to 7. 8	Low	B
Clay loam	CL	A-6	100	80 to 90	0. 2 to 0. 8	. 17	7. 8 to 8. 3	Moderate to high.	
Clay loam	CL	A-6	100	55 to 65	0. 2 to 0. 8	. 14	7. 8 to 8. 3	Moderate	

TABLE 6.—*Brief description of the soils and their*

Map symbol	Soil	Description of soil and site	Depth from surface
			Inches
PtB	Pratt loamy fine sand, undulating.	Well-drained, sandy soil of the uplands; nearly level to undulating.	0 to 66
PvC	Pratt and Tivoli soils, rolling.	Tivoli soil, for which properties are here given, is a loose, sandy soil of the uplands within areas of undulating to duny topography. Slopes of this complex are variable. See Pratt loamy fine sand, undulating, for description of Pratt soil in this complex.	0 to 60
Rg	Rough broken land.	Hilly, broken escarpments in the uplands; there has been no development of a profile in the soil material; clays and shales of the red beds are exposed, and stones are on the surface; slopes are variable.	[1]
ShB	Shellabarger loamy sand, 0 to 4 percent slopes.	Well-drained, sandy soil of the uplands.	0 to 20 20 to 51 51 to 60
TaB	Tillman silt loam, 1 to 3 percent slopes.	Deep, well-drained soil of the uplands; the subsoil is heavy clay.	0 to 8 8 to 31 31 to 70
TpA TpB	Tipton loam, 0 to 1 percent slopes. Tipton loam, 1 to 3 percent slopes.	Deep, well-drained, loamy soils of the uplands.	1 to 23 23 to 68 68 to 84
Ts	Treadway soils.	Poorly drained, unweathered, compact clay on alluvial fans and aprons below outcrops of clayey red beds.	0 to 8 8 to 50
VcB	Vernon clay, 1 to 3 percent slopes.	Shallow, compact clay over clay of the red beds.	0 to 10 10 to 50
VsC VsE	Vernon soils, 3 to 5 percent slopes. Vernon soils, 5 to 12 percent slopes.	Compact, clayey soils; occasional outcrops of rock and gravel on the steeper slopes. Properties given here are for portion of soil areas that consist of Vernon clay loam; for properties of remaining portion of same soil areas, see description of Vernon clay, 1 to 3 percent slopes.	0 to 10 10 to 17 17+
Wa	Waurika silt loam.	Deep, nearly level soil of the uplands; slow internal drainage; the subsoil contains a heavy claypan at a depth of 10 to 12 inches.	0 to 12 12 to 39 39 to 72
Ya	Yahola fine sandy loam.	Deep, well-drained, moderately sandy soil of the bottom lands; subject to occasional overflow.	0 to 22 22 to 56
ZaB ZaC ZaC2	Zaneis loam, 1 to 3 percent slopes. Zaneis loam, 3 to 5 percent slopes. Zaneis loam, 3 to 5 percent slopes, eroded.	Well-drained, loamy soils of the uplands; considerable sheet and gully erosion has occurred on the eroded phase.	0 to 11 11 to 47 47 to 75
Zn3	Zaneis soils, severely eroded.	Loamy soils of the uplands that have undergone severe sheet and gully erosion; see description of Zaneis loams.	-----------
ZsB	Zaneis-slickspot complex, 1 to 3 percent slopes.	Well-drained soil of the uplands and numerous areas of a highly dispersed slickspot soil; see descriptions of Zaneis loams for Zaneis portion.	-----------

[1] Physical properties variable.

estimated physical and chemical properties—Continued

Classification			Percentage passing sieve—		Permeability	Available water capacity	Reaction	Shrink-swell potential	Hydrologic soil group
USDA texture	Unified	AASHO	No. 10	No. 200					
					Inches per hour	*Inches per inch*	*pH*		
Loamy fine sand	SM	A-2	100	15 to 25	2.5 to 5.0	.07	7.0 to 7.8	Low	A
Fine sand	SM or SP	A-3	100	5 to 15	5.0 to 10.0	.05	7.5 to 8.0	Low	A
(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Loamy sand	SM	A-2	100	15 to 25	5.0 to 10.0	.07	6.8 to 7.3	Low	A
Sandy loam	SM	A-4	100	40 to 50	0.8 to 2.5	.12	6.0 to 6.5	Low to moderate.	
Sandy clay loam	SM	A-4	100	20 to 40	0.8 to 2.5	.12	6.3 to 6.8	Moderate	
Silt loam	CL-ML	A-4	100	80 to 90	0.2 to 0.8	.17	5.8 to 6.3	Moderate	C
Clay	CL	A-7	100	85 to 95	0.05 to 0.2	.17	7.0 to 8.0	Moderate to high.	
Clay	CL	A-7	100	85 to 95	0.05 to 0.2	.17	7.8 to 8.3	Moderate to high.	
Loam	CL-ML	A-4	100	70 to 85	0.8 to 2.5	.13	6.8 to 7.3	Low	B
Clay loam	CL	A-6	100	75 to 90	0.8 to 2.5	.14	7.3 to 7.8	Moderate	
Clay loam	CL	A-6	100	75 to 90	0.8 to 2.5	.14	7.8 to 8.3	Moderate	
Clay loam	CL, CH	A-7	100	80 to 90	0.05 to 0.1	.14	7.8 to 8.3	High	C
Clay	CL, CH	A-7	100	80 to 90	0.05 to 05	.17	7.8 to 8.3	High	
Clay	ML-CL	A-7	100	80 to 90	0.05 to 0.2	.14	7.8 to 8.3	Moderate	C
Clay	CL	A-7	100	85 to 96	0.02 to 0.5	.14	7.8 to 8.3	Moderate to high.	
Clay loam	CL	A-7	100	75 to 85	0.05 to 0.2	.14	7.8 to 8.3	Moderate	C
Clay loam	CL	A-7	100	75 to 85	0.05 to 0.2	.17	7.8 to 8.3	Moderate to high.	
Clay	CL	A-7	100	80 to 90	0.05 to 0.2	.17	7.8 to 8.3	Moderate to high.	
Silt loam	ML	A-4	100	80 to 90	0.2 to 0.8	.16	6.0 to 7.0	Low	C
Clay	CH	A-7	100	85 to 95	0.05 to 0.2	.17	7.3 to 7.8	High	
Silty clay loam	CL, CH	A-6 or A-7	100	80 to 90	0.05 to 0.2	.17	7.5 to 8.0	High	
Fine sandy loam	SM	A-2	100	25 to 45	2.5 to 5.0	.12	7.0 to 7.5	Low	B
Loamy fine sand	SM	A-2	100	20 to 30	2.5 to 5.0	.12	7.8 to 8.3	Low	
Loam	CL-ML	A-4	100	50 to 60	0.8 to 2.5	.14	6.5 to 7.0	Low	C
Silty clay loam	CL	A-6	100	80 to 90	0.2 to 0.8	.16	6.8 to 7.3	Moderate to high.	
Clay loam	SC	A-4	100	40 to 50	0.8 to 2.5	.16	7.3 to 7.8	Moderate	

TABLE 7.—*Interpretation of soil*

Soil series and map symbol	Suitability as source of—			Soil features affecting—	
	Topsoil	Sand and gravel	Road fill	Highway location	Farm ponds
					Reservoir areas
Breaks-alluvial land complex (Ba).	(1)	(1)	(1)	(1)	(1)
Broken alluvial land (Bd).	Good	Unsuitable	Fair to poor	Subject to frequent flooding.	Low seepage
Chickasha (ChA)	Good	Unsuitable	Fair	No detrimental features.	Moderate seepage
Enterprise (ErA, ErB, ErC, ErD).	Good	Unsuitable	Fair; erodible	Erodible in cut slopes.	Excessive seepage
Eroded clayey land (Es).	Poor	Unsuitable	Poor	Highly plastic soil material.	Low seepage
Foard (FoA)	Surface layer good, other layers poor.	Unsuitable	Poor	Highly plastic clay	Low seepage
Foard-slickspot complex (FsA, FsB).	Poor	Unsuitable	Unsuitable; dispersed soils.	Highly plastic clay; poor stability in dispersed areas.	Low seepage
Foard and Tillman (FtB).	Surface layer good, other layers poor.	Unsuitable	Poor	Highly plastic soil material.	Low seepage
Lawton (LaA, LaB, LaC, LaC2).	Good	Fair; local beds of gravel and sand; good for subbase for pavements.	Good	No detrimental features.	Moderate to low seepage.
Lincoln (Ls)	Poor	Good; substratum contains well-graded sands and gravels[2] suitable for use in concrete.	Fair; good when slopes are stabilized.	Subject to flooding; high water table.	Excavated ponds; high water table.
Lucien[3]-Zaneis-Vernon complex (Lz).	Poor	Unsuitable	Fair	Soft sandstone is near the surface.	Moderate seepage; soft sandstone is near the surface.
Miller (Mr)	Poor	Unsuitable	Poor	Highly plastic clay; subject to flooding.	Low seepage; nearly level areas can be used for excavated ponds.
Port clay loam (Po)	Good	Unsuitable	Fair	Bottom lands; subject to occasional flooding.	Low seepage; nearly level areas suitable for excavated ponds.
Port loam (Pr)	Good	Unsuitable	Surface layer good; substratum fair.	Bottom lands; subject to occasional flooding.	Low seepage; nearly level areas suitable for excavated ponds.
Port-slickspot complex (Ps).	Poor	Unsuitable	Unsuitable; dispersed soils.	Bottom lands; subject to occasional flooding; dispersed soils subject to settlement and piping.	Low seepage; nearly level areas suitable for excavated ponds.

See footnotes at end of table.

properties that affect engineering

Soil features affecting—Continued					
Farm ponds—Con. Embankments	Irrigation	Terraces and diversions	Waterways	Sewage disposal fields	Building foundations
(1)	(1)	(1)	(1)	(1)	(1).
Stable; impervious	Frequent flooding	Stable fill material	Good fertility	Subject to frequent flooding.	Subject to frequent flooding; moderate to high shrink-swell potential.
Fairly stable; impervious.	Favorable intake rate and water-holding capacity.	No detrimental properties; nearly level.	Good fertility	Moderate percolation rate.	Moderate to high shrink-swell potential.
Fairly stable; semipervious to impervious.	Variable slopes; otherwise favorable features.	Subject to wind and water erosion.	Good fertility; subject to wind and water erosion.	Moderate percolation rate.	Stable, well-graded material.
Poor stability; subject to cracking.	Nonarable; low producing.	Poor stability; subject to cracking.	Vegetation difficult to establish.	Unsuitable; very slow percolation rate.	Plastic soil material; high shrink-swell potential.
Fairly stable; impervious; subject to severe cracking.	Low intake rate; unsuitable for sprinkler method.	Stable as fill material.	Droughty; subsoil low in fertility.	Unsuitable; very slow percolation rate.	Plastic clay with high shrink-swell potential.
Unstable; contains areas of a slickspot soil; highly dispersed.	Unsuitable; very slow intake rate; low producing in areas of the slickspot soil.	Poor stability in areas of dispersed soil material.	Vegetation difficult to establish; droughty; subject to erosion.	Unsuitable; very slow percolation rate.	Unstable; plastic clay.
Fairly stable; subject to cracking.	Low intake rate; shallow permissible depth of cut; unsuitable for sprinkler method.	Stable as fill material.	Droughty; subsoil low in fertility.	Unsuitable; very slow percolation rate.	Highly plastic soils with high shrink-swell potential.
Stable; impervious	Favorable intake rate and water-holding capacity.	Stable as fill material.	Soil properties suitable.	Moderate percolation rate.	Moderate to high shrink-swell potential.
High seepage; slopes easily eroded.	Subject to frequent flooding.	Sandy; unstable; nearly level.	Unstable sand; susceptible to wind erosion.	High percolation rate but subject to flooding.	Loose sands; high water table.
Fairly stable as fill: slopes subject to erosion.	Nonarable; shallow soil.	Fairly stable	Sandstone is near the surface.	Unsuitable because sandstone is near the surface.	Fairly stable where sandstone is near the surface.
Fairly stable as fill; impervious.	Slow intake rate; unsuitable for sprinkler method of application.	Stable as fill; nearly level.	Surface crusting; subject to cracking; droughty	Unsuitable; very slow percolation rate.	Highly plastic clay; high shrink-swell potential.
Stable; impervious	Slow intake rate; unsuitable for sprinkler method of application.	Stable as fill; nearly level.	Deep, fertile soil material.	Subject to flooding	Subject to flooding.
Stable as fill	Favorable intake rate and water-holding capacity.	Stable as fill; nearly level.	Deep, fertile soil material.	Subject to flooding	Subject to flooding.
Unstable as fill; dispersed soil material.	Unsuitable; low-producing areas of a slickspot soil.	Unstable; nearly level.	Vegetation difficult to establish.	Subject to flooding; very slow percolation rate.	Subject to flooding; highly unstable.

TABLE 7.—*Interpretation of soil*

Soil series and map symbol	Suitability as source of—			Soil features affecting—	
	Topsoil	Sand and gravel	Road fill	Highway location	Farm ponds — Reservoir areas
Pratt (PtB)	Poor	Fair as a source of sand and suitable for subbase of pavements.	Good when slopes are stabilized.	Soil material unstable on slopes.	Rapid seepage
Pratt and Tivoli (PvC).[4]	Poor	Fair as a source of sand and suitable for subbase of pavements.	Good when slopes are stabilized.	Duny sands; highly erodible.	Rapid seepage
Rough broken land (Rg).	Unsuitable	Unsuitable	Poor	Breaks and steep slopes; unweathered clays, rocks, and shales.	Low seepage; shale and rock.
Shellabarger (ShB)	Poor	Fair as a source of sand for concrete in local areas.	Good	Subject to erosion	Moderate seepage
Tillman (TaB)	Surface layer good, other layers poor.	Unsuitable	Poor	Soil material highly plastic.	Low seepage
Tipton (TpA, TpB).	Good	Unsuitable	Surface layer good; other layers fair.	No detrimental features.	Moderate to low seepage.
Treadway (Ts)	Unsuitable	Unsuitable	Poor	Highly plastic clay	Low seepage
Vernon clay (VcB)	Unsuitable	Unsuitable	Poor	Soil material highly plastic.	Low seepage
Vernon soils (VsC, VsE).	Unsuitable	Unsuitable	Poor	Steep slopes; soil material highly plastic.	Low seepage
Waurika (Wa)	Surface layer good; other layers poor.	Unsuitable	Poor	Highly plastic clay	Low seepage
Yahola (Ya)	Surface layer good; other layers poor.	Substratum is fair as a source of sand and is suitable for the subbase of pavements.	Good	Occasional flooding	Rapid seepage
Zaneis loam (ZaB, ZaC, ZaC2).	Good	Unsuitable	Fair	No detrimental features.	Low seepage
Zaneis soils, severely eroded (Zn3).	Poor	Unsuitable	Fair	No detrimental features.	Low seepage
Zaneis-slickspot complex (ZsB).	Poor	Unsuitable	Unsuitable; dispersed soils.	Poor stability in areas of dispersed soils.	Low seepage

[1] Materials variable.
[2] Well-graded sands and gravels are those that have a wide range of sizes with most sizes represented.
[3] Interpretations here are for Lucien component of complex; see Zaneis and Vernon series for interpretations for other components of complex.

properties that affect engineering—Continued

Soil features affecting—Continued					
Farm ponds—Con.	Irrigation	Terraces and diversions	Waterways	Sewage disposal fields	Building foundations
Embankments					
Semipervious; subject to erosion.	Sprinkler method preferred; rapid intake rate; low water-holding capacity.	Unstable; subject to severe wind erosion.	Low fertility	High percolation rate.	Fairly stable; low shrink-swell potential.
Pervious; highly susceptible to erosion.	Unsuitable; nonarable.	Unsuitable; unstable sand.	Unstable sands; low fertility.	High percolation rate.	Loose sands; affected only slightly by moisture change.
Subject to cracking, piping, and erosion.	Unsuitable; nonarable.	Unsuitable	Unsuitable; infertile; subject to erosion.	Unsuitable; low percolation rate.	Plastic clay with high shrink-swell potential.
Fairly stable; semipervious.	Suitable only for sprinkler method because of rapid intake rate.	Unstable; sand subject to erosion.	Subject to erosion	Moderate percolation rate.	Stable, well-graded material.
Fairly stable fill; impervious.	Unsuitable for sprinkler method because of slow intake rate.	Stable as fill	Droughty; infertile subsoil.	Unsuitable; very slow percolation rate.	Plastic soil with high shrink-swell potential.
Stable as fill; impervious.	Favorable intake rate and water-holding capacity.	No detrimental features.	Good fertility	Moderate percolation rate.	Moderate shrink-swell potential.
Impervious; subject to piping.	Unsuitable; nonarable.	Fairly stable fill; subject to cracking.	Infertile; droughty	Unsuitable; slow percolation rate.	Plastic clay; high shrink-swell potential.
Stable fill; subject to erosion and cracking.	Unsuitable; low intake rate and low-producing soil.	Stable as fill; shallow over clay.	Infertile; droughty	Unsuitable; slow percolation rate.	Clay with high shrink-swell potential.
Stable fill; subject to erosion and cracking.	Unsuitable; slow intake rate and low-producing soil.	Stable as fill; shallow over clay.	Infertile; droughty; subject to water erosion.	Unsuitable; slow percolation rate.	Clay with moderate to high shrink-swell potential.
Stable fill	Unsuitable for sprinkler method because of slow intake rate.	Stable as fill	Droughty; level	Unsuitable; slow percolation rate.	Highly plastic clay with high shrink-swell potential.
Fairly stable; semipervious.	Rapid intake rate; low water-holding capacity.	Fairly stable as fill; nearly level.	Fertile; subject to deposition by wind and water.	High percolation rate, but subject to flooding.	Stable, well-graded material; occasional flooding.
Fairly stable; impervious.	Favorable intake rate and water-holding capacity.	Stable as fill	No detrimental features.	Unsuitable; slow percolation rate.	Moderately plastic clay.
Fairly stable; impervious.	Unsuitable; low-producing; infertile.	Stable as fill	Lack of good topsoil; infertile.	Unsuitable; slow percolation rate.	Moderately plastic clay.
Unstable; areas of a highly dispersed slickspot soil.	Unsuitable; very slow intake rate; areas of a low-producing slickspot soil.	Poor stability in areas of dispersed soil.	Vegetation difficult to establish; droughty; subject to erosion.	Unsuitable; very slow percolation rate.	Unstable; contains dispersed soil with high shrink-swell potential.

[4] Interpretations here are for Tivoli soil of this complex; see Pratt series for the Pratt soil of this complex.

TABLE 8.—*Engineering test data for soil samples*

Soil name and location	Parent material	Oklahoma Report No.	Depth	Horizon
			Inches	
Enterprise very fine sandy loam: 700 feet S. and 900 feet E. of NW. corner sec. 13, T. 5 S., R. 13 W. (Modal profile).	Windblown sands and silts (Recent).	SO–9877	0–16	A_1
		SO–9878	16–56	C_1
Foard silt loam: 100 feet E. and 1,320 feet N. of SW. corner sec. 11, T. 2 S., R. 13 W. (Modal profile).	Permian red beds.	SO–9879	0–9	A_p
		SO–9880	9–17	B_{21}
		SO–9881	56–66	C
Foard-slickspot complex: 800 feet N. and 175 feet E. of SW. corner sec. 28, T. 2 S., R. 11 W. (Modal profile).	Permian red beds.	SO–9873	0–7	A
		SO–9874	8–18	B_2
		SO–9875	35–65	C
Lawton loam: 450 feet E. and 450 feet N. of SW. corner sec. 25, T. 1 S., R. 11 W. (Modal profile).	Granitic mountain outwash over Permian red beds.	SO–9885	0–10	A_1
		SO–9886	15–26	B_{21}
		SO–9887	60–72	C_1
175 feet S. and 50 feet W. of E. ¼ corner sec. 5, T. 4 S., R. 11 W. (B_{ca} horizon).	Granitic mountain outwash over Permian red beds.	SO–9882	0–8	A_p
		SO–9883	18–30	B_{22}
		SO–9884	40–52	C_1
Miller clay: 100 feet E. and 50 feet N. of S ¼ corner sec. 29, T. 3 S., R. 12 W. (Modal profile).	Alluvium.	SO–9893	2–24	A_{12}
		SO–9894	34–52	C_1
		SO–9895	52–86	C_2
Port loam: 800 feet W. and 400 feet N. of SE. corner sec. 11, T. 2 S., R. 11 W. (Modal profile).	Alluvium.	SO–9888	0–20	A_{11}
		SO–9889	30–62	C_1
		SO–9890	62–72	C_2
Vernon clay: SW¼NW¼ sec. 5, T. 2 S., R. 11 W. (Modal profile).	Clays and shales of Permian age.	SO–9891	0–7	A
		SO–9892	18–72	C_2
Zaneis loam: 1,000 feet E. and 75 feet N. of S. ¼ corner sec. 28, T. 2 S., R. 10 W. (Modal profile).	Clays, silts, and sandstone of Permian age.	SO–9896	0–7	A_p
		SO–9897	11–32	B_2
		SO–9898	47–60	C_1

[1] Tests performed by the Oklahoma Department of Highways in accordance with standard procedures of the American Association of State Highway Officials (AASHO).

[2] Mechanical analyses according to AASHO Designation T 88. Results by this procedure frequently differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes of soils.

Tipton and Lawton soils have developed on the smooth, loamy areas. Pratt, Enterprise, and Tivoli soils have developed on the more sandy, undulating to duny areas.

Recent.—The Recent formations are the alluvial deposits on flood plains that are subject to overflow. This material, which is less than 20 feet thick in most places, consists mainly of sand, silt, and clay. Small amounts of coarser material, however, are present in some places. The soils formed in Recent alluvium are members of the Lincoln, Yahola, Miller, and Port series.

Climate

The climate of this county is classed as subhumid because the amount of rainfall that is effective for plant growth is much less than that in the cooler, more humid parts of the United States. During the growing season, winds are hot and dry and humidity is low. Rainfall, though fairly well distributed, is seldom plentiful enough for water to soak into the subsoil, except in the most sandy, permeable soils. Based on 35-year records kept at the Walters weather station, the average temperature in sum-

taken from 10 soil profiles in Cotton County [1]

Shrinkage		Volume change from field moisture equivalent	Mechanical analysis [2]						Liquid limit	Plasticity index	Classification	
			Percentage passing sieve—			Percentage smaller than—						
Limit	Ratio		No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.005 mm.	0.002 mm.			AASHO [3]	Unified [4]
		Percent										
18	1. 73	5	--------	100	71	46	13	12	22	2	A-4(7)	ML.
17	1. 77	5	--------	100	63	44	13	11	21	3	A-4(6)	ML.
17	1. 78	7	100	96	86	72	21	18	24	5	A-4(8)	ML-CL.
9	2. 02	81	100	98	93	84	54	49	61	30	A-7-5(20)	MH-CH.
9	2. 08	68	100	97	91	80	48	41	50	26	A-7-6(16)	CL.
16	1. 78	8	--------	100	87	73	21	18	24	5	A-4(8)	ML-CL.
9	2. 02	66	--------	100	93	83	48	44	55	28	A-7-6(18)	CH.
9	2. 06	65	--------	100	89	78	44	38	45	24	A-7-6(15)	CL.
19	1. 71	11	100	93	66	51	16	13	26	4	A-4(6)	ML-CL.
14	1. 90	34	100	94	70	57	32	28	34	13	A-6(8)	CL.
14	1. 90	27	100	96	67	53	29	26	31	13	A-6(8)	CL.
16	1. 82	13	100	90	68	48	18	15	25	6	A-4(7)	ML-CL.
8	2. 03	61	100	94	81	67	42	39	49	25	A-7-6(16)	CL.
12	1. 94	31	100	79	53	42	25	23	32	14	A-6(5)	CL.
9	2. 05	72	--------	--------	99	93	60	49	54	26	A-7-6(17)	MH-CH.
10	2. 05	53	--------	100	94	80	43	37	44	22	A-7-6(14)	CL.
9	2. 09	64	100	99	93	84	49	41	51	29	A-7-6(18)	CH.
16	1. 80	18	--------	100	75	60	24	20	27	8	A-4(8)	CL.
15	1. 90	35	100	99	86	75	40	35	37	17	A-6(11)	CL.
13	1. 91	26	--------	100	54	45	30	28	31	13	A-6(5)	CL.
24	1. 54	26	100	94	82	74	41	34	45	18	A-7-6(12)	ML-CL.
20	2. 04	48	100	98	96	90	63	50	45	22	A-7-6(14)	CL.
16	1. 85	9	100	99	57	40	21	18	23	5	A-4(4)	ML-CL.
11	1. 97	43	--------	100	88	58	39	37	37	15	A-6(10)	CL.
16	1. 83	16	--------	100	47	39	28	26	28	10	A-4(2)	SC.

[3] Based on Standard Specifications for Highway Materials and Methods of Sampling and Testing (Pt. 1, Ed. 8): The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes. AASHO Designation: M 145-49.

[4] Based on the Unified Soil Classification System, Tech. Memo. No. 3-357, v. 1, Waterways Expt. Sta. Corps of Engin. March 1953.

mer is 81.4° F. During the summer, there is only about 7.9 inches of rainfall, and much of that is lost through evaporation and transpiration.

Climate is directly or indirectly the cause of many variations in plant and animal life. Thus, climate affects the changes in soils that are brought about by plant and animal life.

Plant and animal life

Grasses and other herbaceous plants, trees and shrubs, micro-organisms, earthworms, and various other forms of plants and animal life live on and in the soils. They are active agencies in soil-forming processes. The nature of the changes that these various agencies bring about depends, among other things, on the kinds of life and the life processes peculiar to each. The kinds of plants and animals that live on and in the soils are determined by environmental factors, including climate, parent material, relief, age of the soils, and the associated organisms. The influence of climate is most apparent, but not in all places the most important, as a determinant of the kinds of microflora that grow on the well-drained soils in which clearly expressed horizons have developed.

Living micro-organisms and burrowing animals help to mix the upper layers of soils. Various bacteria that thrive in a slightly acid material help to decompose organic matter and to release nutrients to plants. The products of decomposition, particularly those from grasses, are not highly acid and do not cause rapid soil leaching.

The effects on soils that result from differences in vegetation are discussed in the paragraphs that follow.

Tall, mid, and short grasses originally covered 85 to 90 percent of the area that is now Cotton County. On the uplands the original vegetation was tall grasses, but some mid and short grasses were present. Few, if any, trees were growing on the uplands when the county was opened for settlement. On the flood plains, the original vegetation was a dense stand of trees, but tall grasses also grew there in places.

Grasses and trees have different effects on the soils that support them. Grasses can use nearly all of the rain that falls during the growing season. Thus, they largely prevent leaching of the basic elements in the soil solution. Also the thick, fibrous roots of tall and mid grasses penetrate the soil to a depth of 18 to 36 inches. The organic matter accumulated from the roots helps to produce the granular structure that is typical of a soil formed under grass, and it increases the capacity of the soil to hold available moisture.

Tall grasses originally grew chiefly on loam, sandy loam, or clay loam soils. Short and mid grasses were dominant on the rest of the soils. The short grasses have a shallower root system than the tall and mid grasses, but they absorb most of the summer rainfall. Short grasses become dormant in very dry weather and resume growth if moisture becomes available later. Thus, these grasses are adapted to regions of low and medium rainfall.

Bluestem grasses require larger amounts of basic elements than do oak trees. They logically should be the dominant vegetation on soils formed in alluvium that is rich in minerals. Several kinds of hardwood trees that grow well on lowlands, however, also have high requirements for basic elements and are well suited to soils formed in alluvium. If the trees are removed or heavily thinned, a thick cover of grass soon grows on these soils.

The trees that originally grew on soils formed in alluvium and colluvium were mixed hardwoods. Trees characteristically have deep roots and limited fibrous ones. Soils formed under trees normally do not accumulate such large supplies of organic matter as do the soils formed under grass. Trees may each year produce a great amount of litter, such as leaves and twigs. This litter falls on the soils, but it is not worked deeply into the soils on uplands.

Soils on uplands that developed under hardwoods are not like those that formed on alluvium under the same kinds of trees. On the flood plains, fresh alluvium may accumulate occasionally and largely offset the effects of leaching.

Organic materials that have gradually been mixed with fresh alluvium extend to a considerable depth through the soil. Most of the soils of Cotton County that formed in alluvium are deep and fertile, and nearly all have a surface layer that is visibly darkened by organic matter.

Topography

Topography ranges from nearly level to strongly sloping or rolling. Topography modifies, to some extent, the effects of climate and vegetation. On the steepest areas much water runs off. As a consequence, geologic erosion keeps almost an even pace with the weathering of rocks and the formation of soils.

In such steep areas soil materials are constantly moved by erosion or gravity so that soils that have genetically related horizons do not form.

Some soils are nearly level and have lain in place for long periods of time. In these a distinct claypan or cemented B horizon has formed.

Time

Time is important in the formation of parent material of soils. Furthermore, it is important in the formation of soils from parent material. The length of time required for development of a soil depends on other factors involved. The degree of profile development, for example, depends on the intensity of the different soil-forming factors, or the length of time they have been in effect, and on the nature of the materials from which the soils have formed. If, in a given site, the factors of soil formation have not been in effect long enough to form a soil that has clearly expressed horizons, the soil is considered young or immature. Soils that have very clearly expressed horizons are considered mature.

Classification and Morphology of the Soils

Soils are classified into categories that progressively become more inclusive. In the United States a natural classification system that consists of six categories is used. Beginning at the top, they are the order, suborder, great soil group, family, series, and type.

The highest category consists of three orders, but thousands of soil types are recognized in the lowest category. The suborder and family categories have not been fully developed and, thus, have been little used. Attention has been directed largely toward great soil groups, series, and types. Groups in the highest category of the classification system are the zonal, intrazonal, and azonal orders.

The third category from the top of the classification system—the great soil group—consists of several soil series that have the same general sort of profile. Soils of different series within the same great soil group have, however, significantly different parent material and relief and differ in degree of development.

Soil series and soil types are defined in the section "How Soils Are Named, Mapped, and Classified." The soil series of Cotton County are classified in the following soil orders and great soil groups.

ZONAL:
- Chestnut soils—
  - Pratt.
  - Tipton.
- Reddish Chestnut soils—
  - Foard.
  - Lawton.
  - Tillman.
- Reddish Prairie soils—
  - Chickasha.
  - Shellabarger.
  - Zaneis.

INTRAZONAL:
- Planosols—
  - Waurika.

AZONAL:
- Alluvial soils—
  - Lincoln.
  - Miller.
  - Port.
  - Treadway.
  - Yahola.
- Lithosols—
  - Lucien.
  - Vernon.
- Regosols—
  - Enterprise.
  - Tivoli.

Zonal soils

The zonal order consists of soils that have well-developed profile characteristics that reflect the active factors of soil formation—climate and plant and animal life. The zonal soils developed from parent material that has been in place a long time and that has not been subject to extreme conditions of relief or of parent material. In this county the zonal soils are in three great soil groups—the Chestnut, the Reddish Chestnut, and the Reddish Prairie.

CHESTNUT SOILS

The Chestnut soils occupy a vast area, generally west of the Chernozem belt. They developed in temperate to cool, mainly semiarid regions under a vegetation of mixed short and tall grasses. The Chestnut soils of the Great Plains are characterized by a dark-brown or dark grayish-brown surface layer. The surface layer grades to a lighter gray, calcareous horizon at a depth of 1½ to 3 feet.

In this county the Chestnut soils are those of the Pratt and Tipton series.

Pratt Series

The soils of the Pratt series are loamy fine sands that developed in material blown from the flood plains of the Red River. They occupy irregular, billowy to duny areas, and their slope ranges from 2 to 10 percent. These soils are coarser textured than the Enterprise soils. They are less sandy and more loamy than the Tivoli soils, which consist largely of siliceous sands.

The following describes a typical profile of Pratt loamy fine sand, undulating, in a pasture of native tall grass (300 feet north and 75 feet east of the southwestern corner of section 27, T. 5 S., R. 12 W.):

A—0 to 22 inches, brown (7.5YR 5/4) loamy fine sand; dark brown (7.5YR 3/2) when moist; weak, fine to medium, granular structure; soft when dry, very friable when moist; abundant roots; pH 7.2; gradual boundary.

C—22 to 66 inches +, brown (7.5 YR 5/4) loamy fine sand; dark brown (7.5YR 3/4) when moist; structureless; soft when dry, very friable when moist; abundant roots in upper part, but the number of roots decreases with increasing depth; pH 7.5.

The color of the surface layer ranges to dark brown in the lower areas between hummocks. Also, on many knobs and ridges and in some cultivated fields, the surface layer is light brown and is thin as the result of erosion. The surface layer is neutral to alkaline, and the soil material below it is mostly alkaline.

These soils are somewhat excessively drained; they have little or no surface runoff and have moderately rapid permeability. The native vegetation consists of tall grasses, sand sage, and some yucca.

Most of the acreage is used for native pastures and range, but the nearly level to undulating areas are used for cultivated crops. Yields are only moderate.

Tipton Series

The Tipton soils developed in calcareous, loamy and silty alluvial materials or in windblown materials. These materials were washed or blown from the channel of the Red River. The Tipton soils are associated with the Enterprise soils, but they are less sandy than those soils and have a developed B horizon. Their subsoil is less compact and less clayey than that of the Foard soils. The slope ranges from 0 to 3 percent.

The following describes a typical profile of a nearly level Tipton loam in a cultivated field (about 850 feet west and 50 feet north of the quarter-section corner on the southern boundary of section 29, T. 4 S., R. 11 W.):

A_{1p}—0 to 7 inches, brown (7.5YR 4/3) loam; dark brown (7.5YR 3/3) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; pH 7.0; abrupt boundary (plow shear).

A_{12}—7 to 17 inches, brown (7.5YR 4/4) loam; dark brown (7.5YR 3/3) when moist; moderate, fine to medium, granular structure; hard when dry, friable when moist; many pores and worm casts; pH 7.0; clear boundary.

B_1—17 to 23 inches, brown (7.5YR 5/4) heavy loam; dark brown (7.5YR 3/4) when moist; strong, medium, granular structure; hard when dry, friable when moist; many pores and worm casts; pH 7.2; clear boundary.

B_2—23 to 45 inches, brown (7.5YR 5/4) light clay loam; dark brown (7.5YR 3/4) when moist; moderate, medium, subangular blocky structure; very hard when dry, firm when moist; thin clay films on the surfaces of peds; mildly calcareous at a depth of 34 inches; pH 7.5; clear boundary.

B_{3ca}—45 to 68 inches, yellowish-red (5YR 5/6; 4/6, moist) light clay loam; weak, fine, subangular blocky structure; very hard when dry, very firm when moist; thin, patchy, clay films on the faces of peds; many soft and hard concretions of calcium carbonate ($CaCO_3$); calcareous; pH 8.0; gradual boundary.

C_1—68 to 84 inches, yellowish-red (5YR 5/6; 4/6, moist) light clay loam; weak, fine, blocky structure to massive; very hard when dry, very firm when moist; few small ferruginous concretions; many soft and hard concretions of calcium carbonate ($CaCO_3$); pH 8.0.

The color of the A and B horizons ranges from brown to reddish brown. The texture of the B horizons ranges from heavy loam to light clay loam, but in most places it is light clay loam. A zone of lime accumulation normally occurs in the lower part of the B horizon or in the upper part of the substratum.

The Tipton soils are well drained and are moderately permeable. The vegetation is mid and tall grasses, mainly bluestem, switchgrass, and Indiangrass.

The Tipton soils are important agriculturally, but they are not extensive in this county. Most of the acreage is cultivated. The principal crops are small grains, cotton, and sorghum.

REDDISH CHESTNUT SOILS

The Reddish Chestnut soils developed on the grassy, rolling, red plains that extend from southern Kansas southward through Oklahoma and Texas to the Gulf of Mexico. The climate is warm-temperate and is semiarid

or subhumid. The surface layer of these soils is brown to dark reddish brown and friable. The subsoil is finer textured and tougher than the surface layer. It is reddish brown to red in the upper part and lighter or grayer and highly calcareous in the lower part. The parent material in this county ranges from weak to compact, moderately to highly calcareous clay of the red beds or moderately gravelly old alluvium washed from nearby granitic mountains. The Reddish Chestnut soils are fairly high in natural fertility, but the small amount of rainfall and the high rate of evaporation tend to limit the growth of crops.

The Reddish Chestnut soils in Cotton County are those of the Foard, Lawton, and Tillman series.

Foard Series

The soils of the Foard series are nearly level to gently sloping and developed over clayey red beds of Permian age. They are associated with the Tillman and Waurika soils. The Foard soils are less red than the Tillman soils, and they have a claypan in the subsoil that is lacking in the Tillman soils. They lack the distinct A_2 horizon that is typical of the Waurika soils.

The following describes a typical profile of a nearly level Foard silt loam in a cultivated field (100 feet east and 1,320 feet north of the southwestern corner of section 11, T. 2 S., R. 13 W.):

A_p—0 to 9 inches, brown (10YR 5/3) silt loam; dark brown (10YR 3/3) when moist; weak, fine, granular structure; hard when dry, friable when moist; weak surface crust; pH 6.4; abrupt boundary (plowed).

B_{21}—9 to 17 inches, dark-brown (7.5YR 4/2) clay; very dark brown (7.5YR 2/2) when moist; strong, medium, angular blocky structure; faces of blocks dark colored in upper 2 inches; very hard when dry, very firm when moist; continuous, thin clay films; common, slickenside faces; fine roots predominant between peds; pH 7.7; gradual, wavy boundary.

B_{22}—17 to 22 inches, dark-brown (7.5YR 4/2; 3/2, moist) clay; moderate, medium, subangular blocky structure; very hard when dry, very firm when moist; thin, patchy clay films; slickensides common; a small amount of medium and coarse sand evident; few fine roots between peds; pH 7.9; clear, wavy boundary.

B_{ca1}—22 to 29 inches, dark-brown (7.5YR 4/4; 3/4, moist) clay; weak, blocky structure; very hard when dry, very firm when moist; slickenside faces less common and weaker than in layer just above; soft concretions and blotches of segregated lime make up about 2 percent, by volume, of soil mass; soil mass is calcareous; pH 8.2; diffuse boundary.

B_{ca2}—29 to 38 inches, brown (10YR 5/3; 4/3, moist) light silty clay; very weak, blocky structure to massive; very hard when dry, very firm when moist; concretions and blotches of lime about the same as in layer just above; fine veins of salt are common; pH 8.2; gradual boundary.

B_{31}—38 to 48 inches, brown (7.5YR 5/2; 4/2, moist) silty clay; very weak, coarse, subangular blocky structure; few weak slickenside faces; very hard when dry, firm when moist; concretions of lime and veins of salt are less numerous than in B_{ca2} horizon; fine, reddish mottles around large grains of sand; pH 8.0; gradual boundary.

B_{32}—48 to 56 inches, yellowish-red (5YR 5/6; 4/6, moist) light silty clay; distinct, fine mottles of gray and brown; weak, blocky structure; slickenside faces more common than in layer just above; very hard when dry, firm when moist; medium and coarse sand more common than in layer just above; pH 8.0; diffuse boundary.

C—56 to 66 inches, yellowish-red (5YR 4/6) silty clay, mottled with gray and black; moderate blocky structure; slickenside faces common; very firm; pH 8.1.

The color of the A horizon when dry, ranges from brown to grayish brown. In most places the texture of the surface layer is silt loam, but in some places it is clay loam. In most places the soil material is calcareous at a depth of 20 to 24 inches or more, but in some places it is calcareous at a depth of only 15 inches. In places there is no well-developed horizon of calcium carbonate accumulation.

The Foard soils are moderately well drained and are very slowly permeable. The vegetation is mainly short grasses. Some areas in pasture are being invaded by mesquite trees.

Most of the acreage is cultivated. A large acreage is used to grow small grains, and a smaller acreage is used to grow cotton and sorghum.

Lawton Series

The Lawton soils are on old terraces along the major creeks in the county. They developed in old alluvium from granitic outwash deposited by streams that flow from the Wichita Mountains. The Lawton soils are associated with the Foard and Tillman soils, but they lack the clayey, compact subsoil that is typical of those soils and they formed in a different kind of parent material. The surface layer of the Lawton soils is less sandy than that of the Shellabarger soils, and their subsoil is more clayey. These soils have slopes of 0 to 5 percent.

The following describes a typical profile of a Lawton loam in a pasture of native grass where the slopes are 1 to 2 percent (450 feet east and 450 feet north of the southwestern corner of section 25, T. 1 S., R. 11 W.):

A_1—0 to 10 inches, dark-brown (7.5YR 4/4; 3/2, moist) loam; weak to moderate, medium, prismatic and moderate, medium, granular structure; slightly hard when dry, friable when moist; abundant roots; many worm casts and rootlet channels; open pores; few grains of granitic sand; pH 7.0; clear boundary.

B_1—10 to 15 inches, reddish-brown (5YR 4/4) light clay loam; dark reddish brown (5YR 3/3) when moist; moderate, fine, blocky structure; hard when dry, firm when moist; few fine roots; porous; few worm casts; few pores and rootlet channels open; pH 7.0; clear boundary.

B_{21}—15 to 26 inches, reddish-brown (5YR 4/4) clay loam; dark reddish brown (5YR 3/4) when moist; moderate, medium to fine, blocky structure; hard when dry, firm when moist; patchy clay films on the outer faces of peds; few grains of granitic sand; pH 7.3; gradual boundary.

B_{22}—26 to 34 inches, reddish-brown (5YR 4/4) clay loam; dark reddish brown (5YR 3/3) when moist; moderate, medium to fine, blocky structure; hard when dry, firm when moist; few clay films on the vertical faces of peds; few to numerous grains of granitic sand and some small, granitic pebbles; pH 7.5; gradual boundary.

B_3—34 to 60 inches, reddish-brown (5YR 5/4) clay loam; dark reddish brown (5YR 3/4) when moist; weak, fine, blocky structure; hard when dry, friable when moist; few grains of granitic sand and small pebbles; contains saprolitic masses of weathered, igneous pebbles; abrupt, wavy boundary.

C_1—60 to 72 inches +, yellowish-red (5YR 5/6; 4/6, moist) clay loam; weak, fine, blocky structure to massive; hard when dry, friable when moist; numerous soft patches of calcium carbonate ($CaCO_3$); soil mass is calcareous; pH 8.0.

The color of the surface layer ranges from dark brown to reddish brown, and in some places the texture of the surface layer is silt loam. The color of the B horizon

ranges from reddish brown to red, and the texture of that horizon ranges from clay loam to light clay. Depth of the C_1 horizon ranges from 60 to 70 inches.

The Lawton soils are well drained but are slowly permeable. The native vegetation consists largely of tall and mid grasses. Most of the acreage is used to grow small grains and cotton.

Tillman Series

The soils of the Tillman series developed in clays from red beds of Permian age. They are associated mainly with the Foard and Vernon soils. The Tillman soils are more reddish than the Foard soils, have a developed B_1 horizon, and lack the compact claypan that is typical in the subsoil of the Foard soils. They differ from the Vernon soils, which also developed on clayey red beds, in that the Vernon soils are Lithosols. The Tillman soils have slopes of 1 to 3 percent. In most places the texture of their surface layer is silt loam.

The following describes a representative profile of a Tillman silt loam in a pasture of native grass (300 feet west and 150 feet north of the quarter-section corner on the southern boundary of section 11, T. 2 S., R. 12 W.):

A_1—0 to 8 inches, brown (7.5YR 4/3) silt loam; dark brown (7.5YR 3/3) when moist; moderate, medium, granular structure; hard when dry, friable when moist; many fine roots; few fine pores; few worm casts; pH 6.0; clear boundary.

B_1—8 to 12 inches, reddish brown (5YR 4/3) light clay loam; dark reddish brown (5YR 3/3) when moist; moderate, medium, subangular blocky structure; hard when dry, firm when moist; many roots; pH 6.0; clear boundary.

B_2—12 to 20 inches, reddish-brown (5YR 4/4) light clay; dark reddish brown (5YR 3/4) when moist; moderate, fine, angular blocky structure; very hard when dry, very firm when moist; coatings of clay on the outer faces of the peds; weakly calcareous below a depth of 15 inches; pH 7.0; clear boundary.

B_{3ca}—20 to 31 inches, red (2.5YR 4/6) light clay; dark red (2.5YR 3/6) when moist; weak, medium, blocky structure to massive; very hard when dry, very firm when moist; very few fine roots; numerous soft and hard concretions of calcium carbonate ($CaCO_3$), strongly calcareous; pH 8.0; clear boundary.

C_1—31 to 47 inches, yellowish-red (5YR 5/6; 4/6, moist) heavy clay loam; massive; very hard when dry, very firm when moist; very few fine roots; few hard and soft concretions of calcium carbonate ($CaCO_3$), strongly calcareous; pH 8.0; gradual boundary.

C—47 to 70 inches, yellowish-red (5YR 5/6; 4/6, moist) light clay; massive; hard when dry, very firm when moist; weakly calcareous; pH 8.0.

The color of the A horizon when dry, ranges from brown to reddish brown. In some places the texture of the surface layer is clay loam. The B_2 horizon in some areas is calcareous throughout. In places the B_{3ca} horizon is weakly developed and contains a few masses of segregated calcium carbonate.

These soils are well drained, but permeability is very slow. The vegetation consists of short and mid grasses, but some pastures have been invaded by mesquite trees. The Tillman soils are extensive and important to agriculture in Cotton County. Most of the acreage is used to grow small grains, sorghum, and cotton.

REDDISH PRAIRIE SOILS

The Reddish Prairie soils are in the southern part of the tall-grass prairie region of the United States. Many areas of these soils are reddish, a color derived more from the parent material than from the processes of soil development. The surface layer of these soils is generally grayish-brown to brown, slightly acid loam that has a granular structure. The subsoil is normally grayish-brown to reddish-brown clay loam to clay that is granular to blocky. The parent material ranges from material weathered from siltstone or fine-grained sandstone to weakly consolidated beds of clay or reconsolidated alluvium.

The Reddish Prairie soils of Cotton County are those of the Chickasha, Shellabarger, and Zaneis series.

Chickasha Series

The Chickasha soils developed under tall grasses in material weathered from sandstone and sandy shale. They are nearly level and occur on broad ridgetops. The Chickasha soils are less red than the Zaneis soils, and their profile is developed to a greater depth. They are also more acid and more loamy than the Zaneis soils, and they are more nearly level.

The following describes a typical profile of a Chickasha loam in a cultivated field that has had little or no erosion (about 850 feet west and 100 feet north of the quarter-section corner on the southern boundary of section 5, T. 2 S., R. 9 W.):

A_p—0 to 7 inches, dark grayish-brown (10YR 4/2) light loam; very dark grayish brown (10YR 3/2) when moist; slightly hard when dry, friable when moist; pH 6.0; clear boundary (2-inch transition).

A_1—7 to 12 inches, dark grayish-brown (10YR 4/2) loam; very dark grayish brown (10YR 3/2) when moist; weak, medium, granular structure; slightly hard when dry, friable when moist; many fine pores and a few worm casts visible; pH 6.0; clear boundary.

B_1—12 to 17 inches, dark-brown (10YR 4.3; 3/3, moist) light clay loam; compound, weak, medium, granular and fine, subangular blocky structure; hard when dry, friable when moist; few fine pores and worm casts visible; pH 6.0; clear boundary.

B_{21}—17 to 27 inches, dark-brown (10YR 4/3; 3/3, moist) clay loam; few, fine, distinct mottles of reddish brown (5YR 5/4); moderate, medium, subangular blocky structure; very hard when dry, firm when moist; pH 6.2; clear boundary.

B_{22}—27 to 33 inches, dark yellowish-brown (10YR 4/4, 3/4, moist) heavy clay loam; common, medium, distinct mottles of reddish brown (5YR 5/4); compound weak, medium, subangular and moderate, medium, subangular blocky structure; very hard when dry, firm when moist; pH 6.2; clear boundary.

B_3—33 to 43 inches, yellowish-brown (10YR 5/6) sandy clay loam; dark yellowish brown (10YR 4/6) when moist; common, medium, distinct mottles of reddish yellow (7.5YR 6/8); porous; massive; hard when dry, firm when moist; pH 6.2; gradual boundary.

C_1—43 to 60 inches, pale-brown (10YR 6/3) sandy clay loam; brown (10YR 5/3) when moist; many, medium, prominent, red (2.5YR 4/6) mottles; massive; hard when dry, firm when moist; pH 6.5.

The color of the A horizon ranges from dark grayish brown to brown, and that of the B_2 horizon, from dark brown to yellowish brown or reddish brown. The texture of the B_2 horizon is clay loam to sandy clay loam. Distinct reddish or grayish mottles are common in the B_3 horizon and below.

The Chickasha soils are well drained and are moderately permeable. The native vegetation consists of tall prairie grasses, mainly little bluestem, Indiangrass, and switchgrass.

Most of the acreage is cultivated. The Chickasha soils are not extensive in the county, but they are important to agriculture. The principal crops are small grains, cotton, and sorghum, but some alfalfa is grown.

Shellabarger Series

The soils of the Shellabarger series are loamy sands that border the flood plains of West Cache Creek. They developed in granitic outwash from the Wichita Mountains. Their surface layer is more sandy than that of the associated Lawton soils, and their subsoil is less clayey. Their surface layer is coarser textured than that of the Pratt soils, and they have a B horizon that is lacking in the Pratt soils. The Shellabarger soils have slopes of 1 to 4 percent.

The following describes a typical profile of a Shellabarger loamy sand that has slopes of 2 percent, in a cultivated field (1,350 feet south and 50 feet east of the northwestern corner of section 1, T. 2. S., R. 13 W.):

A—0 to 20 inches, grayish-brown (10YR 5/2) loamy sand; very dark grayish brown (10YR 3/2) when moist; structureless; slightly hard when dry, very friable when moist; many roots; pH 7.0; clear boundary.

B_1—20 to 25 inches, yellowish-brown (10YR 5/4) sandy loam; dark brown (10YR 4/3) when moist; weak, fine to moderate, medium, granular structure; slightly hard when dry, friable when moist; few roots; pH 6.0; clear boundary.

B_2—25 to 51 inches, yellowish-red (5YR 5/6; 4/6, moist) light sandy clay loam; weak, medium, blocky structure; hard when dry, friable when moist; pH 6.5; clear boundary.

C_1—51 to 60 inches, yellowish-red (5YR 4/6; 3/6, moist) light sandy clay loam; weak, fine, blocky structure to massive; very hard when dry, firm when moist; pH 6.5.

The color of the A horizon ranges from grayish brown to reddish brown, and the thickness of that horizon ranges from 10 to 20 inches. The color of the B_2 horizon ranges from yellowish red to reddish brown, and the texture of that horizon ranges from heavy sandy loam to sandy clay loam.

The Shellabarger soils are well drained and are slowly permeable. The native vegetation consists of big and little bluestem, switchgrass, Indiangrass, and other tall grasses.

Most of the acreage is used to grow cotton and sorghum, but some of it is used to grow small grains. Yields are only moderate.

Zaneis Series

The Zaneis soils developed in material weathered from noncalcareous to alkaline, silty shale that is erratically stratified with seams of clay and fine-grained sandstone. The Zaneis soils are associated with the Chickasha and Tillman soils. They are more alkaline and more reddish than the Chickasha soils, and they have stronger slopes. Their subsoil is less compact and less clayey than that of the Tillman soils. The texture of the surface layer is generally loam. Slopes range from 1 to 5 percent.

The following describes a typical profile of a Zaneis loam in a cultivated field on a slope of 2 percent (1,650 feet west and 75 feet north of the southeastern corner of section 28, T. 2 S., R. 10 W.):

A_{1p}—0 to 7 inches, reddish-brown (5YR 4/4) heavy loam; dark reddish brown (5YR 3/4) when moist; weak, medium, granular structure; slightly hard when dry, friable when moist; many fine roots; few pores; few worm casts visible; pH 6.7; abrupt boundary (plow shear).

B_1—7 to 11 inches, red (2.5YR 4/6) light clay loam; dark red (2.5YR 3/6) when moist; moderate to strong, coarse, granular structure; hard when dry, friable when moist; few fine roots; few fine pores and rootlet channels open; pH 6.8; clear boundary.

B_{21}—11 to 20 inches, reddish-brown (2.5YR 4/4) light silty clay loam; dark reddish brown (2.5YR 3/4) when moist; moderate, medium, subangular blocky and moderate, coarse, prismatic structure; hard when dry, firm when moist; few patchy coatings of clay on the outer faces of peds; very few fine roots; pH 7.0; clear boundary.

B_{22}—20 to 32 inches, red (2.5YR 4/6) silty clay loam; dark red (2.5YR 3/6) when moist; weak, fine, blocky structure to massive; very hard when dry, very firm when moist; pH 7.0; clear boundary.

B_3—32 to 47 inches, red (2.5YR 4/6) silty clay loam; dark red (2.5YR 3/6) when moist; weak, prismatic structure that breaks to moderate, coarse, blocky; weak coatings on the vertical faces of peds; hard when dry, friable when moist; pH 7.2; clear boundary.

C_1—47 to 60 inches, red (10R 4/6) sandy clay loam; dark red (10R 3/6) when moist; massive; few small open pores and rootlet channels; few streaks of calcium carbonate ($CaCO_3$); soil mass is noncalcareous; pH 7.5; abrupt boundary.

C—60 to 75 inches +, weak-red (10R 4/4) silty clay loam interbedded with weathered, fine-grained sandstone; dark red (2/5YR 3/6) when moist; strongly calcareous; few soft concretions of calcium carbonate ($CaCO_3$).

The color of the A horizon ranges from brown to reddish brown, and that of the B horizon, from reddish brown to red. The texture of the B horizon ranges from clay loam to silty clay loam.

The Zaneis soils are well drained but have slow permeability. The native vegetation consists of big and little bluestem, Indiangrass, switchgrass, and other prairie grasses. Most of the acreage is used to grow small grains, cotton, and sorghum.

Intrazonal soils

The intrazonal order consists of soils having more or less well-developed soil characteristics that reflect the dominant influence of a local factor of relief or of parent material over the effects of climate and plant and animal life. In this county the intrazonal soils have definite characteristics that result from extremely mild relief or from parent material that contains a large amount of salt or clay. They occur as small areas within larger areas of zonal soils. The intrazonal soils of this county are in the Planosol great soil group.

PLANASOLS

The Planosols developed under a vegetation of short prairie grasses. Their parent material, which contains a large amount of clay, and their relief, which is nearly level to slightly concave, are the dominant factors in their development. Only soils that have a distinct claypan and, in places, a cemented hardpan are classified as Planosols. These soils generally have a grayish-brown or dark grayish-brown surface layer that is slightly acid. Their subsoil is compact, blocky clay. The parent material is mildly alkaline clay from red beds of Permian age. The only Planosols in this county are the soils of the Waurika series.

Waurika Series

The soils of the Waurika series formed under short native grasses over clay beds of Permian age. They are on

broad flats in the uplands and are nearly level or slightly concave. The Waurika soils are distinguished from the Foard soils, with which they are associated, by a distinct A_2 horizon that rests on a compact claypan, or B_{21} horizon. The boundary between the A_2 horizon and the B_{21} horizon is abrupt.

The following describes a typical profile of a nearly level Waurika silt loam in an area that has been cultivated (in the northwestern corner of section 31, T. 3 S., R. 9 W.):

A_{1p}—0 to 6 inches, grayish-brown (10 YR 5/2) silt loam; very dark grayish brown (10YR 3/2) when moist; weak, platy structure in lower 1 inch; soft when dry, friable when moist; many fine roots; pH 5.9; abrupt boundary (plow shear).

A_{12}—6 to 10 inches, dark grayish-brown (10YR 4/2) silt loam; very dark grayish brown (10YR 3/2) when moist; soft when dry, friable when moist; few worm casts and little granulation; pH 6.6; gradual, nearly smooth boundary.

A_2—10 to 12 inches, light brownish-gray (10YR 6/2) silt loam; dark grayish brown (10YR 4/2) when moist; structureless; soft when dry, friable when moist; pH 7.0; abrupt, wavy boundary.

B_{21}—12 to 24 inches, dark grayish-brown (10YR 4/2) clay; very dark grayish brown (10YR 3/2) when moist; moderate, medium to coarse, angular blocky structure; very hard when dry, very firm when moist; moderate, continuous clay films and many horizontal slickenside faces; pH 7.3; clear, wavy boundary.

B_{22}—24 to 32 inches, very dark grayish-brown (10YR 3/2, moist) clay; moderate, medium, angular blocky structure; very hard when dry, very firm when moist; clay films and slickenside faces less apparent than in the layer just above; many concretions of hard lime (1 percent by volume) as much as 1 centimeter in diameter; soil mass is noncalcareous; fine, black pellets, 1 to 2 millimeters in diameter, become more numerous with increasing depth; pH 7.8; diffuse boundary.

B_{3ca}—32 to 39 inches, dark grayish-brown (10YR 4/2, moist) clay; weak, blocky structure that breaks easily on horizontal planes; concretions of lime more numerous (3 percent by volume) than in the layer just above; soil mass is calcareous; pH 7.7; gradual boundary.

C_1—39 to 50 inches, dark grayish-brown (10YR 4/2, moist) heavy clay loam; weak, medium to fine, subangular blocky structure; hard when dry, firm when moist; segregated lime less than 1 percent by volume; soil mass is calcareous; pH 7.8; diffuse boundary.

C_2—50 to 57 inches, dark grayish-brown (10YR 4/2, moist) clay loam; weak, medium, subangular blocky structure; hard when dry, firm when moist; soil mass is calcareous but less so than in the layer just above; segregated lime is less than in the layer just above; black concretions increase in size and in number with increasing depth; pH 7.9; gradual boundary.

C_3—57 to 72 inches, light-gray (10YR 7.2, moist) clay loam, coarsely streaked and mottled with yellowish red (5YR 5/6, moist); structureless; hard when dry, friable when moist; pH 7.8.

The color of the surface layer ranges from grayish brown to dark grayish brown. The A_2 horizon is 2 to 5 inches thick. The color of the B_2 horizon ranges from dark brown to dark grayish brown.

The Waurika soils are moderately well drained and are very slowly permeable. The native vegetation consists of short and mid grasses. Most of the acreage is used to grow cotton and small grains, but a few areas are used for pasture.

Azonal soils

The azonal order consists of soils that lack distinct, genetically related horizons, generally because of youth, resistant parent material, or steep topography. The azonal soils of the county are in the Alluvial, Lithosol, and Regosol great soil groups.

ALLUVIAL SOILS

The Alluvial soils vary greatly from place to place because of the different sediments that made up the parent material. The color, characteristics, and arrangement of the layers are varied in the different soils. Soils of the Lincoln, Miller, Port, Treadway, and Yahola series are in this great soil group. The Miller and Treadway soils are less variable than the others because the clayey alluvium in which they formed was more nearly uniform.

Lincoln Series

The Lincoln soils developed in alluvium on the flood plains of the Red River. They are subject to recurrent flooding and receive deposits of fresh soil material each time they are flooded. The soils are associated with the Yahola soils and are somewhat similar to those soils. The soil material below the surface layer is less reddish, however, and contains more sand. The soils are nearly level to undulating.

The following describes a typical profile of a Lincoln loamy fine sand formed under native tall grasses on a flood plain where the topography is wavy to undulating (NE¼NW¼ sec. 24, T. 5 S., R. 12 W.):

A—0 to 15 inches, light-brown (7.5YR 6/4) loamy fine sand; brown (7.5YR 5/4) when moist; weak, fine to medium, granular structure; soft when dry, very friable when moist; abundant roots; strongly calcareous; pH 8.0; gradual boundary.

C—15 to 50 inches, light-brown (7.5YR 6/4) fine sand; brown (7.5YR 5/4) when moist; structureless; loose when dry, very friable when moist; many roots in uppermost 5 inches, but the number decreases with increasing depth; strongly calcareous; pH 8.0.

The surface layer ranges from light brown to light brownish gray in color. Generally its texture is fine sand to fine sandy loam, but there are minor areas of clay loam and clay in small depressions or swales. In most places these soils are calcareous throughout the profile, but in some places they are neutral or alkaline.

The soils are somewhat excessively drained. Surface drainage is slow, and internal drainage is moderately rapid. The water table commonly is at a depth of 6 to 12 feet. The native vegetation is mainly bluestem, Indiangrass, switchgrass, and other tall grasses. There are also a few to numerous cottonwood trees and willow trees in most places, and saltcedar is dominant in some places.

The Lincoln soils are moderately productive of pasture or range. Almost all of the acreage is used for grazing.

Miller Series

The Miller soils developed in alluvium made up mainly of reddish, calcareous clays and silts. These clays and silts were washed from the surrounding subhumid uplands that are underlain by clays from the red beds of Permian age. The soils are nearly level and occur on flood plains. They are subject to occasional flooding, and the floodwaters deposit fresh clayey sediments. The Miller soils are more reddish and more calcareous than the Port soils with which they are associated, and they contain more clay. They resemble the Treadway soils in color, texture, and reaction, but they formed in alluvium that is more weathered. The

Miller soils also have a more developed structure, are more porous and permeable, and are more productive.

The following describes a typical profile of a nearly level Miller silty clay on a flood plain (50 feet east and 50 feet north of the quarter-section corner of the southern boundary of section 29, T. 3 S., R. 12 W.):

A_{11}—0 to 2 inches, reddish-brown (5YR 5/4) silty clay; dark reddish brown (5YR 3/4) when moist; recent alluvium; weak, thin, platy structure to massive; abundant roots; slightly calcareous; pH 8.0; horizon normally would be obliterated by plowing; abrupt boundary.

A_{12}—2 to 24 inches, reddish-brown (5YR 4/3) clay; dark reddish brown (5YR 3/3) when moist; moderate, fine, blocky structure; crumbly; slightly calcareous; pH 8.0; clear boundary.

A_{1b}—24 to 34 inches, reddish-brown (5YR 4/3) clay; dark reddish brown (5YR 3/2) when moist; weak, fine, blocky structure; very hard when dry, very firm when moist, very sticky and plastic when wet; few fine roots; pH 8.0; clear boundary.

C_1—34 to 52 inches, reddish-brown (5YR 4/4) clay; dark reddish brown (5YR 3/4) when moist; massive; very hard when dry, very firm when moist; few soft and few hard concretions of calcium carbonate ($CaCO_3$); strongly calcareous; pH 8.0; gradual boundary.

C—52 to 86 inches, red (2.5YR 4/6) clay; dark red (2.5YR 3/6) when moist; very hard when dry, very firm when moist; strongly calcareous; numerous soft and a few hard concretions of calcium carbonate ($CaCO_3$); pH 8.5.

The color of the surface layer ranges from reddish brown to brown. In some small areas the texture of the surface layer is fine sandy loam, silt loam, or clay loam. In cultivated areas the surface soil separates to a mass of fine, extremely hard blocks or aggregates upon drying. These soils are generally calcareous, but some areas are noncalcareous and are alkaline.

The Miller soils are moderately well drained and are very slowly permeable. The native vegetation consists mainly of buffalograss, vine-mesquite, and other short grasses. A few elm, hackberry, and mesquite trees, however, grow along entrenched channels.

Most of the acreage is in wheat, sorghum, and cotton. Yields are only moderate.

Port Series

The Port series consists of brown to dark reddish-brown, noncalcareous soils formed in alluvium. The soils are nearly level and are on the flood plains of creeks throughout the county. They have a weak color and reaction profile, but they have only a slightly developed textural profile. Their surface layer is mainly loam or clay loam and overlies clay loam to silty clay. The Port soils are associated with the Miller soils. Their profile contains less clay, however, than that of the Miller soils, and it is noncalcareous to a depth of at least 15 inches. The Port soils are darker and contain less sand than the Yahola soils. The lower part of their profile, especially, is less sandy than that of the Yahola soils.

The following describes a typical profile of a Port clay loam in a field used for wheat, on a nearly level area of bottom land (NW¼NW¼ sec. 24, T. 2 S., R. 11 W.):

A_{11}—0 to 20 inches, dark-brown (7.5YR 3/2) heavy clay loam; very dark brown (7.5YR 2/2) when moist; moderate, medium, granular structure; slightly hard when dry, firm when moist; few fine pores; pH 7.0; clear boundary.

A_{12}—20 to 29 inches, dark-brown (7.5YR 3/2) clay loam; very dark brown (7.5YR 2/2) when moist; moderate, fine, subangular blocky structure; slightly hard when dry, firm when moist; few pores; pH 7.5; clear boundary.

C_1—29 to 46 inches, dark reddish-brown (5YR 3/2) clay loam; dark reddish brown (5YR 2/2) when moist; weak, fine, subangular blocky structure; hard when dry, firm when moist; small patches of segregated calcium carbonate; mildly calcareous at a depth of 29 inches; pH 8.0; clear boundary.

C—46 to 60 inches, reddish-brown (5YR 4/3) clay loam; dark reddish brown (5YR 3/3) when moist; weak, fine, subangular blocky structure; hard when dry, firm when moist; numerous soft and hard concretions of calcium carbonate; strongly calcareous throughout; pH 8.0.

The following describes a typical profile of a Port loam in a cultivated field on a nearly level to slightly undulating area of bottom land (800 feet west and 400 feet north of the southeastern corner of section 11, T. 2 S., R. 11 W.):

A_{11}—0 to 20 inches, dark-brown (7.5YR 4/3; 3/2, moist) loam; moderate, medium, granular structure; slightly hard when dry, friable when moist; abundant roots; porous, few pores and rootlet channels open; worm casts visible in lower part (10 to 20 inches); pH 7.5; clear boundary.

A_{12}—20 to 30 inches, dark-brown (7.5YR 4/3; 3/2, moist) silt loam; moderate, medium, granular structure; hard when dry, friable when moist; few roots and worm casts; pH 7.5; clear boundary.

C_1—30 to 62 inches, reddish-brown (5YR 4/3) clay loam; dark reddish brown (5YR 3/3) when moist; moderate, medium, subangular blocky structure; very hard when dry, firm when moist; weakly calcareous in spots; pH 8.0; clear boundary.

C—62 to 72 inches, red (2.5YR 4/6) clay loam; dark red (2.5YR 3/6) when moist; natural cleavage lines separate along vertical faces; nearly massive; slightly hard when dry, friable when moist; pH 8.0; soil mass calcareous; few strings and small patches of soft concretions of calcium carbonate.

The color of the surface layer ranges from brown to dark reddish brown. The texture of the substratum ranges from clay loam to silty clay, and the reaction of the substratum, from alkaline to calcareous.

The Port soils are moderately well drained and are moderately permeable. The native vegetation was a forest of deciduous trees interspersed with tall grasses. The Port soils are the most extensive soils of the bottom lands, and they are important to agriculture. Most of the acreage has been cleared and is used to grow small grains, cotton, and alfalfa.

Treadway Series

The Treadway soils do not have an evident solum, and they lack distinct structure. Their parent material has been transported only short distances from the beds of only slightly weathered, red clay from which it originated. It consists of reddish, mostly calcareous, slightly weathered, clayey alluvium.

These soils are nearly level and occur on fans, aprons, flats, and flood plains. They resemble the Miller soils, but the material in which they formed is less weathered. They are droughty and contain only a small amount of plant nutrients and organic matter. Little vegetation grows on the areas.

The following describes a typical profile of a nearly level Treadway clay loam used for pasture (in the southeastern corner of section 8, T. 4 S., R. 12 W.):

C_1—0 to 8 inches, reddish-brown (2.5YR 4/4) light clay loam; dark reddish brown (2.5YR 3/4) when moist; weak, platy structure in upper 1 inch, massive below; hard when dry, firm when moist; many fine roots in upper 5 inches; mildly calcareous on surface; pH 8.0; clear boundary.

C_2—8 to 31 inches, reddish-brown (5YR 5/3; 4/3, moist) light clay or silty clay; weak, platy structure to massive; hard when dry, firm when moist; strongly calcareous, pH 8.0; clear boundary.

C_3—31 to 50 inches, dark-brown (7.5YR 4/2; 3/2, moist) clay; massive; very hard when dry, firm when moist; strongly calcareous; pH 8.0.

The color of the surface layer ranges from reddish brown or red to strong brown or brown, and the texture of the surface layer, from clay to clay loam. The soils are structureless (massive) in some areas, but in places they have a blocky structure. The reaction of the surface layer ranges from moderately calcareous to noncalcareous or mildly alkaline.

These soils are well drained. They are droughty and have very slow permeability. The vegetation consists mainly of a sparse cover of short grasses, pricklypear, and mesquite trees.

The Treadway soils are not suited to cultivated crops. They are used mainly for range of low carrying capacity.

Yahola Series

The Yahola series consists of somewhat reddish, calcareous soils formed in alluvium. They are nearly level to gently undulating and are on flood plains. In most places both the surface layer and the underlying material are fine sandy loam. The Yahola soils are more reddish than the Lincoln soils with which they are associated, and they occupy a slightly higher position on the flood plains of the Red River. They contain more sand than the Miller soils.

The following describes a typical profile in a nearly level area of Yahola fine sandy loam that has been cultivated (about 600 feet east and 100 feet north of the southwestern corner of section 13, T. 5 S., R. 12 S.):

A_p—0 to 6 inches, reddish-brown (5YR 5/4) fine sandy loam; dark reddish brown (5YR 3/4) when moist; weak, fine, granular structure; soft when dry, very friable when moist; many pores; pH 7.0; abrupt boundary.

A_{12}—6 to 22 inches, reddish-brown (5YR 5/4) fine sandy loam; dark reddish brown (5YR 3/4) when moist; weak, fine to moderate, granular structure; soft when dry, very friable when moist; few small pores; moderately calcareous; pH 7.5; clear boundary.

C_1—22 to 56 inches, light reddish-brown (5YR 6/4) loamy fine sand; reddish brown (5YR 5/4) when moist; structureless; soft when dry, very friable when moist; strongly calcareous; pH 8.0.

The color of the A horizon ranges from light brown to reddish brown. In most places the texture of the A horizon is fine sandy loam, but there are small areas of other textures. The surface layer is noncalcareous to mildly calcareous, and the lower layers are strongly calcareous to moderately alkaline. The degree of stratification varies widely in the substratum.

The Yahola soils are well drained and are moderately permeable. The native vegetation is mainly tall grasses, but there are scattered cottonwood and hackberry trees. The soils are used mainly to grow cotton, small grains, and sorghum.

LITHOSOLS

Lithosols show little or no evidence of profile development and consist mainly of a partly weathered mass of rock fragments, of nearly bare rock, or of unconsolidated beds of clay. In some places the covering of soil material over consolidated parent material is thin. In other places the beds of clay are on steep slopes and the clay has not weathered deeply because water seldom percolates far into it. Most Lithosols are sloping or strongly sloping, and much of the soil material is removed as it forms. Thus, new rock or clay is constantly exposed to weathering, and only a thin layer of soil material develops. Lithosols strongly reflect the character of the rock or clay beds from which they form and the vegetation under which they develop. The Lucien and Vernon soils are the Lithosols in this county.

Lucien Series

The Lucien series consists of brown to reddish-brown soils that are gently sloping to strongly sloping. The soils formed under grass in material weathered from noncalcareous, soft, fine-grained sandstone. They are more friable and contain more sand than the Vernon soils with which they are associated, and they are noncalcareous rather than calcareous. The Lucien soils are shallower over bedrock than the Zaneis soils, and they lack a developed B_2 horizon. They occur only in a complex with the Vernon and Zaneis soils.

The following describes a typical profile of a Lucien very fine sandy loam in a pasture of native grass on a north-facing slope of 3 percent (900 feet south and 100 feet east of the northwestern corner of section 26, T. 1 S., R. 10 W.):

A_1—0 to 4 inches, brown (7.5YR 5/3) very fine sandy loam; dark brown (7.5YR 4/3) when moist; weak, fine, granular structure; slightly hard when dry, very friable when moist; open pores; abundant roots; pH 7.0; clear, wavy boundary.

A_3—4 to 10 inches, brown (7.5YR 5/4) very fine sandy loam; dark brown (7.5YR 4/4) when moist; weak, fine, granular structure; slightly hard when dry, very friable when moist; many roots; porous; pH 7.0; abrupt boundary.

D_r—10 inches +, light reddish-brown (5YR 6/4), soft sandstone; reddish brown (5YR 5/4) when moist; pH 7.5; this horizon is interbedded with red clay in many places.

The color of the A horizon ranges from brown to reddish brown, and in some places the A horizon has a texture other than very fine sandy loam. The reaction of the A horizon ranges from neutral to medium acid. The thickness of the solum ranges from about 2 inches in the stony areas to about 20 inches in the nonstony areas.

The Lucien soils are excessively drained and are moderately permeable. The native vegetation consists of tall and mid grasses. These soils are used mainly for pasture and range. Yields of forage are moderate.

Vernon Series

The soils of the Vernon series developed in beds of reddish, calcareous clay that is compact and nearly impervious. They are undulating to rolling and are in the uplands. These soils are more clayey and compact than the Lucien soils with which they are associated. They also developed in finer textured material and are calcareous.

The Vernon soils developed in the same kind of parent material as the Tillman soils, but their profile is thinner and they have no developed B horizon. The parent material of the Vernon soils is somewhat similar to that of the Treadway soils. The Vernon soils have a better developed profile, however, and are on uplands rather than on alluvial flats and fans below outcrops of unweathered clay.

The following describes a profile of a gently sloping Vernon clay in a cultivated field (450 feet east and 50 feet north of the southwestern corner of section 18, T. 3 S., R. 12 W.):

A—0 to 10 inches, reddish-brown (2.5YR 4/4) clay; dark reddish brown (2.5YR 3/4) when moist; moderate, fine, blocky structure; very hard when dry, very firm when moist; strongly calcareous; pH 8.0; gradual boundary.

C_1—10 to 28 inches, red (2.5YR 4/6) clay; dark red (2.5YR 3/6) when moist; weak, fine, blocky structure to massive; extremely hard when dry, very firm when moist; many small and hard concretions of calcium carbonate ($CaCO_3$); strongly calcareous; pH 8.0; gradual boundary.

C—28 to 50 inches, red (2.5YR 4/6) clay; dark red (2.5YR 3/6) when moist; massive; extremely hard when dry, very firm when moist; many small, hard concretions of calcium carbonate ($CaCO_3$); and a few soft concretions; strongly calcareous; pH 8.0.

In some places the color of the A horizon ranges to dark red or strong brown. In areas of these soils near the Red River, a mantle of windblown, loamy material has been deposited over the clay beds. The depth to unweathered red shale or clay ranges from 8 to 25 inches. The areas where the A horizon is thickest are generally at the foot of slopes where accumulations of soil material are the greatest. The surface layer ranges from slightly alkaline to strongly calcareous in reaction.

These soils are well drained, but they are very slowly permeable and are droughty. The vegetation consists mainly of short and mid grasses, but mesquite trees have invaded in some areas.

Most of the acreage of Vernon soils is used for pasture or range. Some of the smooth areas, however, where the soil material is fairly deep, are used to grow small grains and sorghum. Yields are low to moderate.

REGOSOLS

Regosols are young, slightly developed soils that lack distinct profile characteristics. They are forming in very fine sandy loam, loamy fine sand, and fine sand. These loamy and sandy soils have not been in place long; consequently, they are not greatly weathered. Their profiles generally have a darkened A horizon and an underlying, slightly weathered C horizon. The Regosols in this county are in the Enterprise and Tivoli series.

Enterprise Series

The Enterprise series consists of young soils that are alkaline. The soils developed in very fine sands and silts recently blown from the channel of the Red River. These soils are more loamy and are less siliceous than the Tivoli soils. They lack the developed textural B horizon that is typical in the associated Tipton soils. The Enterprise soils are finer textured than the Pratt soils. Their slope ranges from 0 to 8 percent, but in most places these soils are nearly level or gently sloping.

The following describes a typical profile of an Enterprise very fine sandy loam in a nearly level field used for cotton (900 feet east and 700 feet south of the northwestern corner of section 13, T. 5 S., R. 13 W.):

A_1—0 to 16 inches, brown (7.5YR 5/4) very fine sandy loam; dark brown (7.5YR 3/3) when moist; weak, fine to medium, granular structure below plow depth; soft when dry, very friable when moist; pH 7.0; clear boundary.

C_1—16 to 56 inches +, brown (7.5YR 5/4; 4/4, moist) very fine sandy loam; weak, fine to medium, granular structure; hard when dry, friable when moist; pH 7.5.

The color of the surface layer ranges from brown to reddish brown. The surface layer ranges from noncalcareous to calcareous and is neutral or mildly alkaline in reaction. The lower layer is strongly calcareous or moderately alkaline.

The Enterprise soils are well drained and are moderately permeable. The native vegetation consists of tall and mid grasses.

These soils are used mainly to grow cotton, small grains, sorghum, and alfalfa, but some small areas are used for pasture. Good yields of forage crops and of cultivated crops are obtained.

Tivoli Series

The Tivoli series consists of light-colored, loose sands that have no textural profile. The parent material is windblown sand, which is mainly of Quaternary age. The only evidence of soil development consists of staining by organic matter and of an accumlation of organic matter, which has darkened the uppermost few inches. The subsoil of the Tivoli soils is more sandy than that of the associated Pratt and Enterprise soils.

The following describes a typical profile of a Tivoli fine sand in an undulating area of pasture in native tall grass (near the center of section 33, T. 5 S., R. 12 W.):

A—0 to 6 inches, brown (7.5YR 5/4; 4/3, moist) fine sand; single grain; soft when dry, very friable when moist; many fine roots; pH 7.5; clear boundary.

C—6 to 60 inches, reddish-yellow (7.5YR 7/6; 6/6, moist) fine sand; single grain; loose when dry, very friable when moist; pH 8.0.

The color of the surface layer ranges from pale brown to yellowish brown or light brown, and that of the subsoil, from reddish yellow to pale brown and pink. The texture of the surface layer is fine sand or loamy fine sand.

The Tivoli soils are undulating and have stabilized dunes as much as 25 feet high. They are excessively drained and have very rapid permeability. The native vegetation consists mainly of tall grasses, but in places there is sand sage, yucca, and scrubby hackberry trees. The Tivoli soils are not suited to cultivated crops. They are used for range, but the amount of forage obtained from the native grasses is low to moderate.

Mechanical and Chemical Analyses of Soils

Data obtained by mechanical and chemical analyses of two selected soils, Foard silt loam and Waurika silt loam, are given in table 9. The data are useful to soil scientists in classifying soils and in developing concepts of the formation of soils. If interpreted properly, the data can

be applied in planning soil management. A detailed description of a profile of a Foard silt loam and of a Waurika silt loam is given in the section on formation and classification.

Field and Laboratory Methods

The samples for which data are given were collected from carefully selected pits. The samples taken are considered representative of the material less than three-fourths of an inch in diameter. Estimates of the fraction larger than three-fourths of an inch in diameter were made during the sampling, and the information was recorded in the description of the profile.

After removing the material larger than three-fourths of an inch, the samples are prepared by rolling or crushing them and sieving to remove individual particles of gravel or rock larger than 2 millimeters in diameter. The material larger than 2 millimeters, but smaller than three-fourths of an inch in diameter, is reported as a percentage greater than 2 millimeters, and the percentage is based on the total weight of material in the sample smaller than three-fourths of an inch. Unless otherwise noted, all laboratory analyses are made using the material passing the 2-millimeter sieve and are reported on an ovendry basis. The following are the chemical and mechanical methods used in making the laboratory determinations.

The mechanical analyses of particle-size distribution are made by the pipette method (*3*, *4*, *5*). The pH is determined by glass electrode. The content of organic carbon is determined by wet combustion, using a modification of the Walkley-Black method (*6*); the content of nitrogen, by a modified procedure of the Association of Official Agricultural Chemists (*2*); and the calcium carbonate equivalent, by measurement of the volume of carbon dioxide evolved from soil samples treated with concentrated HCl.

Cation exchange capacity is determined by direct distillation of absorbed ammonia (*6*). Analysis of extractable calcium and magesium is made by precipitating calcium as calcium oxalate and magnesium as magnesium ammonium phosphate (*6*); extractable sodium and potassium are determined on original extracts with the Beckman DU flame spectrophotometer. In several of the determinations, the amount of soil or chemicals used were varied from that given in the procedure.

General Nature of the County[8]

This section of the report is provided mainly for those not familiar with Cotton County. It tells about the relief and drainage, climate, vegetation, social and industrial development, population, community facilities, industries and natural resources, and agriculture of the county.

Relief and Drainage

Cotton County is in the gently rolling part of the southern Great Plains. The area is a plain underlain by weakly consolidated, reddish clays and sandstone of Permian age. In most parts of the county, there are broad areas of nearly level uplands, but most of the uplands are gently rolling. Several isolated hills capped by resistant sandstone occur in the county. The elevation at Walters is 981 feet.

Most of the county is drained by tributaries of the Red River, but the southern part and the central, north-central, and western parts are drained by the Cache, West Cache, and Deep Red Creeks. The northeastern part is drained by Beaver Creek, which flows southeastward through Jefferson County. Drainage is generally toward the south and southeast.

Deep deposits of old alluvium and loess occur on the former flood plains of the Red River and, to a lesser extent, along the major creeks. Much of the alluvium near the river has been reworked by wind. As a result, there are many dunes and sandy ridges in those areas. A large part of the acreage in such areas is cultivated, but the soils are subject to severe wind erosion.

About one-eighth of the acreage in the county is made up of flood plains, but only about two-thirds of that acreage is suitable for crops. Unfavorable relief, poor drainage, silting, sanding, or other factors limit the use of the rest. Some areas of flood plains are important for agriculture, however, because the soils are deep and fertile.

The Red River has a wide channel that is filled with water after a large amount of rain has fallen. During periods of normal or below-normal rainfall, however, the part of the channel covered by water is narrow and the rest of the channel is bare. When the water is low, high winds blow sand and silt from the exposed streambed. The sand and silt are deposited on the surrounding areas and are the parent material of the Enterprise and Tivoli soils.

Upstream flood control

Deep Red Creek begins near Snyder in Kiowa County. This stream drains the eastern half of Tillman County and runs through Cotton County to the Red River. The creek floods two to six times each year. Any work that would help to control flooding would have to be done in Tillman County, although approximately 10,000 acres in Cotton County would benefit. About 94,110 acres of the watershed of Deep Red Creek is in Cotton County.

West Cache Creek rises in the Wichita Mountains in Comanche County, but approximately 72,894 acres of the watershed of this creek is in Cotton County. In about 42,000 acres of this watershed in Cotton County, the soils are eroded. Floodwaters and sediment have caused damage in an additional 10,620 acres. Damage from flooding was severe until the 1930's when several large lakes were built along the upper reaches of this creek near the Wichita Mountains. Now, although the creek still overflows once or twice each year, damage from flooding is less severe than formerly. West Cache Creek converges with Deep Red Creek about 5 miles from Cache Creek and then flows into Cache Creek about 5 miles from the Red River.

Cache Creek, which rises in the mountains west of Apache in Caddo County, is the largest creek in the county. It flows through Comanche County into Cotton County and empties into the Red River. The watershed of this creek covers 171,929 acres of which 88,730 acres is in Cotton County.

[8] Prepared with the help of JAY SMITH, county superintendent of schools; CHESTER COLEMAN, work unit conservationist, Soil Conservation Service; and CLIFFORD VARNER, school instructor.

TABLE 9.—*Analytical data*

Soil name, and sample and laboratory numbers	Depth	Mechanical analysis: Very coarse sand 2.0 to 1.0 mm.	Coarse sand 1.0 to 0.5 mm.	Medium sand 0.5 to 0.25 mm.	Fine sand 0.25 to 0.10 mm.	Very fine sand 0.10 to 0.05 mm.	Silt 0.05 to 0.002 mm.	Clay <0.002 mm.	>2 mm.	Textural class USDA
	Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*		
Foard silt loam (S59Okla-17-2-(1-8) 11442-11449).	0-9	[2]1.0	[2]3.2	[2]3.1	3.7	10.9	62.5	15.6	--------	Silt loam
	9-17	[2].6	[2]2.1	[2]2.1	2.5	6.1	42.6	44.0	--------	Silty clay
	17-22	[2].9	[2]2.2	[2]2.5	2.7	6.0	43.7	42.0	--------	Silty clay
	22-29	[3]1.1	[3]2.5	[3]2.5	[4]2.7	[4]8.0	47.2	36.0	--------	Silty clay loam
	29-38	[3]1.2	[3]2.4	[3]1.8	[4]2.2	[4]7.6	48.1	36.7	--------	Silty clay loam
	38-48	[3]1.6	[3]2.2	[3]1.3	[4]1.7	[4]7.1	48.2	37.9	(5)	Silty clay loam
	48-56	[3]1.2	[3]2.1	[3]1.4	[4]2.0	[4]7.7	47.6	38.0	(5)	Silty clay loam
	56-66	[3]1.5	[3]2.6	[3]1.5	[4]2.1	[4]7.8	47.0	37.5	--------	Silty clay loam
Waurika silt loam (S59Okla-17-1-(1-9) 11433-11441).	0-6	<.1	[2].1	[2].1	4.7	17.8	63.0	14.3	--------	Silt loam
	6-10	[2].1	.1	[2].1	4.1	15.3	59.3	21.0	--------	Silt loam
	10-12	<.1	[2].2	[2].1	4.4	15.4	57.5	22.4	--------	Silt loam
	12-24	[2].2	[2].1	[2].1	3.0	9.4	38.2	49.0	--------	Clay
	24-32	[6].5	[6].4	[8].2	[4]3.8	[4]10.4	42.3	42.4	(5)	Silty clay
	32-39	[6]1.6	[6].9	[8].3	[4]4.4	[4]10.8	46.0	36.0	(5)	Silty clay loam
	39-50	[6].7	[6].5	[8].2	[4]4.5	[4]11.9	45.2	37.0	(5)	Silty clay loam
	50-57	[7].6	[7].6	[8].2	[4]5.1	[4]12.8	43.8	36.9	--------	Silty clay loam
	57-72	[7].3	[7].4	[8].3	[4]6.9	[4]16.8	40.8	34.5	--------	Clay loam

[1] Analyses by Soil Survey Laboratory, SCS, Lincoln, Nebr.
[2] Common (Fe-Mn?) concretions.
[3] Few (Fe-Mn?) concretions; few calcareous aggregates.
[4] Trace calcareous aggregates

Most flood control work on the Cache Creek watershed would have to be carried out in Comanche County. A total of 50,000 acres has been damaged by erosion, and 15,000 acres, by floodwaters and sediment. The creek overflows four to eight times each year. The soils of the bottom lands are highly productive of commonly grown crops, and approximately 12,000 acres could be irrigated.

Beaver and Little Beaver Creeks are in the northeastern part of the county. They rise near Rush Springs in Grady County. Of the 382,000 acres in the watershed of these creeks, 52,400 acres is in Cotton County. Approximately 21,000 acres has been damaged by erosion, and 9,390 acres has been damaged by overflow and silting. The sandy soils in the upper part of the watershed cause an enormous silting problem in the lower areas along the creek. The creek overflows two to six times every year.

Whiskey Creek is a small stream southeast of Temple. It has about 45,000 acres in the watershed. Of this, 35,000 acres is subject to erosion and 6,000 acres is subject to damage by floodwaters and silting. The prospects are good for controlling flooding along this creek by an upstream project.

Climate[9]

Cotton County has a temperate, continental climate characteristic of the southwestern Great Plains. Masses of air from the north and from the Gulf of Mexico alternately influence the weather in the area. Therefore, daily and seasonal fluctuations in temperature, in the amount of sunshine, in the velocity of the wind, and in the amount of precipitation are often rapid and significant.

The characteristics of the seasons are fairly well defined, but changes between seasons are gradual. Generally, the winter season is short and mild. Polar air masses, which move down from the north as "northers," often cause rapid changes in temperature. Long periods of severe cold and heavy snow, however, are infrequent. Spring is the season when the weather is most variable and when the largest amount of precipitation falls. It is also the season when severe local storms and tornadoes occur most frequently. The summers are long; they are occasionally dry and are generally hot. The heat is not unduly uncomfortable, however, because of the fresh prevailing breezes and low humidity. There are long periods of pleasant weather in fall interspersed with spells of moderate to heavy rains.

Readings of zero or below are rare in Cotton County. They have been observed on only 5 days in 3 different years during the last 30, or the equivalent of 1 year in 10. On the average, there are only 4 days each year when the temperature does not rise above freezing. The temperature in the county has fallen as low as −10° F., however, and has risen as high as 114°.

The warm season is long in this county. Temperatures of 90° occur as early as March and as late as October. Periods when readings are 100° or higher extend from May to October. Temperatures of 90° or higher have occurred on an average of 103 days per year, and temperatures of 100° or higher have occurred on 29 days per year.

[9] Prepared with the help of H. V. LEHRER, State climatologist, U.S. Weather Bureau.

for selected soil profiles [1]

Chemical analysis												
pH		Organic carbon	Nitrogen	Electrical conductivity ($Ec \times 10^3$)	Calcium carbonate equivalent	Cation exchange capacity (NH_4OAc)	Extractable cations					Exchangeable sodium
1:1 ratio	1:10 ratio						Ca	Mg	H	Na	K	
		Percent	*Percent*	*Mmhos. per cm. at 25° C.*	*Percent*	*Meq./100 g. of soil*	*Meq./100 g. of soil*	*Meq./100 g. of soil*	*Meq./100 g. of soil*	*Meq./100 g. of soil*	*Meq./100 g. of soil*	*Percent*
6.4	7.0	0.59	0.051	0.6	----------	10.8	6.3	3.1	2.9	0.6	0.4	5
7.7	8.6	.78	.074	.9	<1	30.3	18.6	10.9	2.5	3.8	.5	11
7.9	8.9	.61	.059	1.4	<1	30.4	18.2	11.7	1.5	4.5	.4	12
8.2	9.4	.36	.032	3.0	4	24.2	--------	--------	--------	5.8	.4	18
8.2	9.4	.21	----------	4.5	3	25.1	--------	--------	--------	7.4	.4	20
8.0	9.1	.17	----------	6.0	3	25.9	--------	--------	--------	8.0	.4	19
8.0	9.3	.10	----------	6.0	4	26.2	--------	--------	--------	8.5	.4	21
8.1	9.4	.05	----------	5.8	8	26.1	--------	--------	--------	8.1	.4	20
5.9	6.6	.74	.058	.4	----------	9.4	6.1	2.0	3.1	.1	.4	1
6.6	7.3	.73	.064	.5	<1	12.9	8.6	3.4	3.4	.5	.3	3
7.0	7.7	.58	.053	.7	<1	14.8	8.8	3.6	2.6	.8	.2	5
7.3	8.2	.66	.056	2.0	<1	33.8	22.0	12.0	2.5	4.2	.5	10
7.8	8.9	.44	----------	4.1	1	28.9	24.2	10.9	.2	5.4	.4	12
7.7	8.6	.25	----------	7.9	2	25.2	28.4	9.9	<.1	5.8	.4	12
7.8	8.9	.17	----------	5.0	2	25.7	19.7	9.4	.2	6.2	.4	16
7.9	8.8	.11	----------	4.2	2	24.7	17.0	8.8	.5	6.1	.4	16
7.8	8.6	.05	----------	3.6	<1	23.1	13.9	7.5	1.2	5.2	.4	16

[5] Trace.
[6] Few (Fe-Mn?) concretions; many calcareous aggregates.
[7] Common (Fe-Mn?) concretions; common calcareous aggregates.
[8] Few (Fe-Mn?) concretions; trace calcareous aggregates.

The greatest number of days in any 1 year when the temperature reached 100° or higher was 67 days. This was in 1956.

The average annual precipitation in Cotton County is about 30 inches. About 33 percent of the precipitation falls in spring; 27 percent, in summer; 25 percent, in fall; and 15 percent, in winter. The amount of precipitation, however, has ranged from as little as 16.46 inches in 1939 to as much as 51.03 inches in 1941. The distribution is generally favorable throughout the growing season.

Dry periods, which materially affect the yields of crops, can be expected occasionally. They extend for various lengths of time, but a complete crop failure is rare. During the last 30 years when records were kept at Walters, there have been only two occasions when no measurable precipitation fell for 2 consecutive months. The occasional heavy rains cause soil erosion, flooding, and damage to crops. Daily amounts of 3 to 5 inches occur about 1 year in 3. The greatest amount that has fallen in any 1 day was 7.5 inches. The average annual rate of evaporation, based on records kept at the weather station at Lawton, in Comanche County, is 53.9 inches.

Snow is not a major source of moisture in this county, although an average of 5 inches falls each year. Heavy snows occur about once or twice each year, but the snow remains on the ground only a few days at the most. The largest amount of snow that has fallen in 1 year was 15 inches, and that amount fell in 1947–48. The largest amount of snow that fell in 1 day was 8 inches, which fell in March 1942. The following gives the number of inches of annual precipitation at the Walters Weather Station for the years 1915 through 1960. Records are not available for the years 1917 to 1922, inclusive.

Year:	*Inches*	Year:	*Inches*
1915	38.19	1941	51.03
1916	19.89	1942	35.61
1923	38.40	1943	24.24
1924	23.83	1944	35.96
1925	34.50	1945	39.02
1926	29.60	1946	29.72
1927	25.09	1947	24.49
1928	28.61	1948	22.69
1929	27.41	1949	31.36
1930	29.52	1950	37.02
1931	29.55	1951	29.34
1932	30.24	1952	20.67
1933	27.25	1953	32.00
1934	21.42	1954	20.58
1935	30.41	1955	35.49
1936	22.75	1956	19.82
1937	23.21	1957	43.03
1938	28.27	1958	21.23
1939	16.46	1959	40.50
1940	35.64	1960	32.14

Average wind speeds are about 12 miles per hour. During the warm months of the year, the prevailing winds are from the south, but they are from the north in winter. Rather strong, gusty winds are fairly common. The strongest winds are associated with violent squall lines and severe thunderstorms that are most common in spring. The winds are rarely severe enough, however, to produce violent duststorms or significant erosion. Since 1875, according to reports, only 11 tornadoes have struck in Cotton County.

The number of hailstorms that cause damage to crops should always be considered in planning agricultural practices. During the past 37 years, 15 hailstorms were reported to have caused damage in the county. Most hailstorms cover a fairly small area. Therefore, the chances are extremely small that a hailstorm will cause damage on any one farm in any given year. According to available data, the probability is that no destructive hailstorms will occur at a given location in 67 percent of the years, that no more than one hailstorm will occur in 94 percent of the years, and that no more than two hailstorms are likely to occur in 99 percent of the years.

Temperatures of freezing or below can seriously affect crops, but this is generally not a serious problem in this county. A freeze-free season of 218 days is generally adequate for crops to mature. Occasionally, warm periods early in spring are followed by a freeze, which causes serious damage to crops. Crops that mature late can be similarly damaged by a freeze early in fall. In this county the date of the latest freeze in spring is April 22. The date of the earliest freeze in fall is October 7. The probable dates of the latest freezing temperatures in spring and the earliest in fall are shown in table 10.

The climate of Cotton County is favorable for agriculture. The average monthly precipitation and temperatures in fall are generally favorable for the preparation of the seedbed and for seeding, germination, and development of the small grains that normally are planted in fall. The precipitation and temperatures are such that roots have a chance to develop so that they will withstand the cold of winter and possible freezeouts. The plants also make enough growth so that they protect the soils from erosion and can be grazed during the fall, winter, and spring months. Similarly, in spring the mild temperatures and the large amount of rainfall are sufficient for small grains to mature, for preparing the soils for seeding, and for planting row crops. Table 11 shows the average temperatures and precipitation at Walters for the period from 1931 to 1960.

TABLE 10.—*Probabilities of the latest freezing temperatures in spring and earliest in fall*

[Based on data from records kept at Chattanooga, Lawton, and Waurika, Okla., for the years 1921–50]

Probability	Dates for given probability and temperature				
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower
Spring:					
1 year in 10, later than.	Mar. 9	Mar. 18	Mar. 27	Apr. 6	Apr. 17.
2 years in 10, later than.	Mar. 1	Mar. 11	Mar. 21	Apr. 1	Apr. 12.
5 years in 10, later than.	Feb. 14	Feb. 24	Mar. 8	Mar. 21	Apr. 2.
Fall:					
1 year in 10, earlier than.	Nov. 21	Nov. 16	Nov. 11	Nov. 1	Oct. 20.
2 years in 10, earlier than.	Nov. 28	Nov. 23	Nov. 18	Nov. 7	Oct. 26.
5 years in 10, earlier than.	Dec. 12	Dec. 8	Dec. 1	Nov. 18	Nov. 5.

TABLE 11.—*Temperature and precipitation data*

[Based on data from records kept at Walters, Cotton County, for the years 1931–1960]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Two years in 10 will have at least 4 days with—		Average monthly total	One year in 10 will have—		Days with snow cover of 1 inch or more	Average depth of snow on days with snow cover
			Maximum temperature equal to or higher than—	Minimum temperature equal to or lower than—		Less than—	More than—		
					Inches	*Inches*	*Inches*	*Number*	*Inches*
January	54	30	72	12	1.26	0.2	2.4	1	2
February	58	34	74	18	1.53	.2	2.9	(1)	2
March	67	40	82	26	1.83	.1	3.7	(1)	3
April	76	50	90	37	2.56	.5	4.5	(1)	3
May	83	60	94	47	5.40	2.6	8.9		
June	92	69	101	59	3.42	1.1	6.4		
July	97	73	105	66	2.33	.4	4.3		
August	97	72	107	65	2.35	.5	4.6		
September	90	64	100	50	2.83	(2)	6.9		
October	79	53	92	39	3.11	.3	6.5		
November	65	39	80	24	1.44	(2)	3.9		
December	56	33	72	20	1.60	.1	3.7	(1)	2
Year	76	51	[3] 107	[4] 8	29.66	20.6	39.0	1	2

[1] Less than 0.5 day
[2] Trace
[3] Average annual maximum.
[4] Average annual minimum.

Vegetation

Native grasses cover about 45 percent of the land area in Cotton County. They grow on nearly all of the uplands not used for cultivated crops and on a large part of the alluvial bottom lands. Elm, oak, hackberry, sycamore, ash, pecan, and other hardwoods originally were common on the bottom lands. Now, the only native trees are those along the creeks and streams. Tall, mid, and short grasses, such as big and little bluestem, Indiangrass, switchgrass, buffalograss, side-oats grama, and blue grama are dominant in the county.

Bluestem and other native grasses decrease in vigor when they are grazed intensively. They are replaced by plants of less value for grazing. The soils in the native pastures become drier and less able to absorb moisture if they are trampled excessively and if the surface litter is removed. On the steep, clayey, and severely eroded soils, proper grazing is needed to maintain enough vegetation to cover the soil.

On loams that have a medium-textured to clayey subsoil, the natural tendency is for some kinds of grasses to persist, even after heavy grazing. Mesquite trees invade old fields and overgrazed pastures, particularly in areas of fine-textured soils. A sizeable acreage in the county is now covered with these undesirable trees.

Social and Industrial Development

The area that is now Cotton County was originally a part of the Kiowa, Comanche, and Apache Indian Reservation. It was opened for settlement August 6, 1901; the settlers were allowed to draw lots for 160 acres and could choose their own quarter section.

In 1907, approximately 207,000 acres, known as Big Pasture, was opened for settlement and was sold to the highest bidder. This acreage, which had formerly been leased to cattlemen, had been under the supervision of the U.S. Government and was owned by the Indians. A part of this acreage is now the southwestern part of Cotton County. Also in 1907, the Oklahoma Territory and the Indian Territory were joined and were admitted as a State.

The area that later became Cotton County was originally a part of Comanche County. About 1910, however, many of the people of the area became dissatisfied because they were too far from the county seat. As a result, they decided to secede and form another county. In 1912, the boundary lines of the new county were established, Cotton County was organized, and the town of Walters was chosen as the county seat. Since the area had been opened for settlement much earlier, it was already well populated. The early settlers came from nearby States, mainly from Texas.

At one time few farms contained more than 160 acres, and there was a home on nearly every quarter section. The power for farming was furnished by horses, and much of the work was done by hand labor. Farming was generally diversified. Cotton was the main cash crop, but feed crops and small grains were grown in rotation.

Little change took place in farming methods from the time of the early settlement to about 1940. Then, the farms became larger, and the number of farms decreased. At one time there were about 1,600 farms in the county, but there were only 851 farms in 1959.

Population.—In 1960, the total population of the county was 8,031. Of this, 2,825, or 35.2 percent, was urban and 5,206, or 64.8 percent, was rural. The population is distributed fairly evenly throughout the county, but the eastern half of the county is the most thickly populated. The most sparsely populated areas are in the southwestern part and along the Red River.

Walters, in the north-central part of the county, had a population of 2,825 in 1960. Temple, had a population of 1,282; Randlett, of 356; and Devol, of 117.

A reduction of 21.0 percent in the total population took place in the county in the 10 years between 1940 and 1950. A further decline of 21.1 percent occurred between 1950 and 1960. This decline in population took place in both the urban and rural areas of the county, but the greatest decrease occurred in the rural areas.

Community facilities.—This county once had more than 70 school districts, including 6 high schools. Now there are only five schools, in addition to a privately owned kindergarten, which is at Walters. The five schools are in Walters, Temple, Randlett, Apheatone, and Hulen.

Churches are numerous in Cotton County, and at least 10 denominations are represented. There are 12 to 15 rural churches in addition to the ones in Walters, Temple, Randlett, and Devol.

Facilities for public transportation include two bus lines that serve Walters and Randlett. Railroad passenger and freight service is available at Temple and Walters. In addition, three motor freight lines offer service to Walters, Temple, and Randlett. An airport southwest of Walters provides service for a few individuals who own planes, but no public airline service is available.

State and U.S. highways crisscross and touch nearly all points of the county. Extensive improvements have been made in the existing highways, and new highways have been built. Between 12 and 15 improved farm-to-market roads serve the rural families. Nearly all of the county roads are kept in good repair.

Facilities for communication by way of telephone, telegraph, radio, and television are excellent throughout the county. Three telephone companies serve this area. A telegraph office is located in Walters, and a number of radio and television stations are near enough for excellent reception.

Electricity for most farms and for small towns of Randlett and Devol is supplied by Cotton Electric Cooperative, under the Rural Electrification Adminstration. Headquarters for this cooperative are located at Walters. Walters purchases its electricity from a power company, and Temple is served directly by this company. A powerline crosses the central part of the county from east to west.

One of the finest golf courses in the State is at Walters. Many tournaments are held there each year, and Walters High School has added golf to its other sports. In addition, Walters High School has three basketball teams, three football teams, and a track team.

Both Walters and Temple have a lake where there is fishing year round and water skiing and boating in season. Walters also has a modern swimming pool that was completed in 1959 and a youth park where there is a summer play program. The park serves some 100 youngsters and employs 2 youth guidance instructors.

Industries and natural resources.—The principal industries in Cotton County are the production of crude petroleum and natural gas. Producing fields nearly surround Walters. Other small fields are located in an area southwest of Temple, and, only a few years ago, a potentially productive field was discovered southwest of Randlett.

The first well that was drilled was completed as a gas well in February 1917. This discovery well led to the development of the Walters field, which is northeast of Walters. A northeastern extension of the Walters field, known as the Keys gasfield, was developed soon after the Walters field began to produce.

The discovery well was the result of a wildcat operation, and prospecting and drilling of experimental wells has never ceased in the county. This continued exploration paid off again in 1946 when a new field was discovered southwest of Walters. Other producing wells just north of Walters have been developed even more recently. Each year new wells are drilled, and some old, shallow wells begin to produce again from deeper sands.

The number of persons employed in the production of crude oil and gas has declined decidedly since the peak was reached in the late 1920's. Many people, however, are still employed in this and in allied industries.

A garment factory is located at Temple. There are also cotton gins and wheat elevators in that town.

Walters Lake is the source of the water supply for Walters. This supply is supplemented by water from wells located in the bottom lands of Cache Creek. Wells in the same general area also supply water for the town of Temple.

Agriculture

During the 40 years after the county was first settled, cotton, corn, and oats were grown year after year on most farms. Legumes were not grown extensively. Only a small amount of fertilizer was used, and little effort was made to improve the soils or to protect them from erosion. Pastures were generally overgrazed, and livestock was grazed on crop residues after the supply of forage was depleted in the pastures. As a result of these farming practices, the soils became seriously eroded and the supply of plant nutrients was depleted in many of the soils.

The most serious erosion occurred in areas where row crops were grown continuously. In addition, the supply of available phosphorus was depleted in many of the soils. Now, nearly all of the crops commonly grown on the soils of the uplands respond to additions of phosphate. The supply of nitrogen, available chiefly from organic matter, has also been reduced, and nitrogen fertilizer is needed if plants are to grow vigorously.

The use of the soils has changed greatly in the past 20 years, partly because of necessity and partly by choice. Small grains and legumes have been grown much more extensively since the late 1930's. Table 12 gives the acreage of the principal crops grown in the county in stated years.

The change from growing row crops almost exclusively to growing small grains has helped to conserve the soils. The reason is that small grains, like grasses, help to protect the soils. When small grains are grown, more organic matter is usually returned to the soils than when a row crop is grown. This is because the part of the small grain that is harvested and removed from the field is only a small part of the total plant. Therefore, most of the plant is returned to the soils.

TABLE 12.—*Acreage of principal crops*

Crops	1929	1939	1949	1959
Wheat harvested	67, 286	35, 181	127, 617	65, 992
Oats harvested	27, 688	21, 250	8, 800	8, 525
Barley harvested	1, 577	6, 161	668	3, 216
Cotton harvested	93, 119	31, 996	20, 868	13, 383
Corn for all purposes	8, 415	3, 633	2, 475	411
Sorghum for all purposes, except sirup	14, 395	6, 213	7, 024	13, 576
Hay crops, total	2, 092	4, 693	6, 073	11, 953

Some fertilizer was used as early as 1929, but until 1948 the quantity used annually in the county did not exceed 100 tons. In contrast, 1,311 tons of fertilizer was used on 41,182 acres of wheat in 1959; 76 tons was used on 1,142 acres of cotton in that year; and 529 tons was used on all other crops. This is much less than the amount that probably should be used for wheat and cotton in Cotton County. The increased use of fertilizer, the improvements in the cropping systems, and the use of improved varieties of wheat and other crops have played an important part in increasing yields for the farmers in the county.

A large acreage of sloping soils has been terraced during the past 20 years. Many of the early terraces, however, were constructed on areas that were later abandoned for crops. Many systems have not been utilized or maintained properly, and they do not provide the beneficial effects for which they were built.

In 1959, there were 851 farms in the county, as compared to 1,179 farms in 1950. The following gives the types of farms in 1959:

	Number
Cash grain farms	220
Livestock farms	220
Cotton farms	42
General farms	143
Dairy farms	5
Miscellaneous and unclassified farms	221

The average size of farms increased from 186 acres in 1930 to 442 acres in 1959. The number of farms operated by owners has decreased slightly. A total of 385 farms was operated by full owners in 1930, as compared to a total of 310 in 1959.

Livestock and livestock products provide a large part of the farm income in Cotton County. Most of this income is derived from the sale of grazing animals, principally beef cattle. The number of cattle in the county has fluctuated according to the demand, but the general trend has been upward. The number and kinds of livestock in the county in stated years are shown in table 13.

Approximately 95 percent of the farms in the county have electricity. In 1959, there were 851 farms in the county and telephones were on 561. Home freezers were on 405 farms. In addition, there were 781 automobiles on 698 farms, 1,255 tractors on 733 farms, 890 trucks on 665 farms, and 238 grain combines on 207 farms.

TABLE 13.—*Number and kinds of livestock on farms*

Livestock	1930	1940	1950	1959
Cattle and calves	[1] 20, 785	[1] 21, 077	26, 187	31, 430
Sheep and lambs	[2] 2, 487	[2] 3, 947	2, 234	4, 230
Hogs and pigs	[1] 2, 475	[3] 3, 163	3, 626	2, 374
Horses and mules	[1] 9, 704	[1] 4, 296	1, 386	480
Chickens	[1] 105, 147	[3] 79, 221	[3] 73, 179	[3] 25, 696

[1] More than 3 months old.
[2] More than 6 months old.
[3] More than 4 months old.

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Glossary

Alluvium. Fine material, such as sand, silt, or clay, that has been deposited on land by streams.

Calcareous soil. A soil containing calcium carbonate, or a soil that is alkaline in reaction because of the presence of calcium carbonate.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Colluvium. Soil material, rock fragments, or both, moved by soil creep, slide, or local wash and deposited at the base of steep slopes.

Concretions. Hard grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds that cement the soil grains together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose. Noncoherent; will not hold together in a mass.

Friable. When moist, crushes easly under gentle to moderate pressure between thumb and forefinger and can be pressed together into a lump.

Firm. When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic. When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a wire when rolled between thumb and forefinger.

Sticky. When wet, adheres to other material; tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard. When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft. When dry, breaks into powder or individual grains under very slight pressure.

Cemented. Hard and brittle; little affected by moistening.

Parent material (soil). The horizon of weathered rock or partly weathered soil material from which soil has formed; horizon C in the soil profile.

Permeability, soil. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are as follows: *Very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Porosity, soil. The degree to which the soil mass is permeated with pores and cavities. Porosity can generally be expressed as a percentage of the whole volume of a soil horizon that is unoccupied by solid particles.

Reaction, soil. The degree of acidity or alkalinity of a soil mass, technically expressed in pH values or in words as follows:

	pH		*pH*
Extremely acid	Below 4. 5	Neutral	6. 6–7. 3
Very strongly acid	4. 5–5. 0	Mildly alkaline	7. 4–7. 8
Strongly acid	5. 1–5. 5	Moderately alkaline	7. 9–8. 4
Medium acid	5. 6–6. 0	Strongly alkaline	8. 5–9. 0
Slightly acid	6. 1–6. 5	Very strongly alkaline	9. 1 and higher

Sand. Individual rock or mineral fragments in soils having diameters ranging from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Silt. Individual mineral particles in soils that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Slickspot soil. A soil that has a surface layer of loam or silt loam, 2 to 8 inches thick, underlain by a solodized B2 horizon, or heavy claypan layer, of stony, coarse, blocky clay. The boundary between the surface layer and the B2 horizon is abrupt. In places, erosion has removed all of the original surface layer, exposing the stony, coarse, blocky clay. Most of these eroded areas have no vegetative cover.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are *platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Substratum. Any layer lying beneath the solum, or true soil; the C or D horizon.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, usually about 5 to 8 inches thick. The plowed layer.

Terrace deposits. Loose, sandy deposits of the Quaternary period; mainly old alluvium, greatly modified and shifted by wind, that was deposited during the Pleistocene epoch.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportions of fine particles are as follows: Sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

GUIDE TO MAPPING UNITS, CAPABILITY UNITS, AND RANGE SITES

[Table 1, p. 8, gives the acreage and proportionate extent of the soils, and table 2, p. 33, gives the estimated yields of crops. Facts about woodland and windbreaks are discussed in the section beginning on p. 39; facts about the uses of the soils for engineering are described in the section "Engineering Uses of the Soils"]

Map symbol	Soil	Page	Capability unit: Symbol	Capability unit: Page	Range site: Name	Range site: Page
Ba	Breaks-alluvial land complex	8	VIe-5	32	Loamy Bottom Land, Red Clay Prairie, and Hardland	37, 37, 36
Bd	Broken alluvial land	8	Vw-2	32	Loamy Bottom Land	37
ChA	Chickasha loam, 0 to 1 percent slopes	9	I-1	26	Loamy Prairie	36
ErA	Enterprise very fine sandy loam, 0 to 1 percent slopes	10	IIc-1	28	Loamy Prairie	36
ErB	Enterprise very fine sandy loam, 1 to 3 percent slopes	10	IIe-1	27	Loamy Prairie	36
ErC	Enterprise very fine sandy loam, 3 to 5 percent slopes	10	IIIe-1	28	Loamy Prairie	36
ErD	Enterprise very fine sandy loam, 5 to 8 percent slopes	10	IVe-1	30	Loamy Prairie	36
Es	Eroded clayey land	10	VIe-1	32	Eroded Clay	37
FoA	Foard silt loam, 0 to 1 percent slopes	11	IIs-1	28	Hardland	36
FsA	Foard-slickspot complex, 0 to 1 percent slopes	11	IIIs-1	30	Hardland and Slickspot	36, 37
FsB	Foard-slickspot complex, 1 to 3 percent slopes	12	IVe-3	31	Hardland and Slickspot	36, 37
FtB	Foard and Tillman silt loams, 1 to 3 percent slopes	12	IIIe-2	29	Hardland	36
LaA	Lawton loam, 0 to 1 percent slopes	13	I-1	26	Loamy Prairie	36
LaB	Lawton loam, 1 to 3 percent slopes	13	IIe-2	27	Loamy Prairie	36
LaC	Lawton loam, 3 to 5 percent slopes	13	IIIe-1	28	Loamy Prairie	36
LaC2	Lawton loam, 3 to 5 percent slopes, eroded	13	IVe-4	31	Loamy Prairie	36
Ls	Lincoln soils	13	Vw-1	31	Sandy Bottom Land	37
Lz	Lucien-Zaneis-Vernon complex	14	VIe-3	32	Loamy Prairie and Red Clay Prairie.	36, 37
Mr	Miller clay	14	IIIs-2	30	Heavy Bottom Land	38
Po	Port clay loam	15	I-2	26	Loamy Bottom Land	37
Pr	Port loam	15	I-2	26	Loamy Bottom Land	37
Ps	Port-slickspot complex	15	Vs-1	32	Loamy Bottom Land and Alkali Bottom Land.	37, 36
PtB	Pratt loamy fine sand, undulating	16	IIIe-4	29	Deep Sand	38
PvC	Pratt and Tivoli soils, rolling	16	VIe-2	32	Deep Sand	38
Rg	Rough broken land	16	VIIs-1	32	Breaks	38
ShB	Shellabarger loamy sand, 0 to 4 percent slopes	17	IIIe-4	29	Deep Sand	38
TaB	Tillman silt loam, 1 to 3 percent slopes	17	IIIe-2	29	Hardland	36
TpA	Tipton loam, 0 to 1 percent slopes	18	I-2	26	Loamy Prairie	36
TpB	Tipton loam, 1 to 3 percent slopes	18	IIe-1	27	Loamy Prairie	36
Ts	Treadway soils	19	VIs-1	32	Red Clay Flats	36
VcB	Vernon clay, 1 to 3 percent slopes	19	IIIe-3	29	Red Clay Prairie	37
VsC	Vernon soils, 3 to 5 percent slopes	19	IVe-2	31	Red Clay Prairie	37
VsE	Vernon soils, 5 to 12 percent slopes	19	VIe-4	32	Red Clay Prairie	37
Wa	Waurika silt loam	20	IIs-1	28	Hardland	36
Ya	Yahola fine sandy loam	20	IIw-1	27	Loamy Bottom Land	37
ZaB	Zaneis loam, 1 to 3 percent slopes	21	IIe-2	27	Loamy Prairie	36
ZaC	Zaneis loam, 3 to 5 percent slopes	21	IIIe-1	28	Loamy Prairie	36
ZaC2	Zaneis loam, 3 to 5 percent slopes eroded	22	IVe-4	31	Loamy Prairie	36
Zn3	Zaneis soils, severely eroded	22	VIe-3	32	Loamy Prairie	36
ZsB	Zaneis-slickspot complex, 1 to 3 percent slopes	22	IVe-3	31	Loamy Prairie and Slickspot	36, 37

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If you wish to file a Civil Rights program complaint of discrimination, complete the USDA Program Discrimination Complaint Form, found online at http://www.ascr.usda.gov/complaint_filing_cust.html or at any USDA office, or call (866) 632-9992 to request the form. You may also write a letter containing all of the information requested in the form. Send your completed complaint form or letter by mail to U.S. Department of Agriculture; Director, Office of Adjudication; 1400 Independence Avenue, S.W.; Washington, D.C. 20250-9419; by fax to (202) 690-7442; or by email to program.intake@usda.gov.

Persons with Disabilities

If you are deaf, are hard of hearing, or have speech disabilities and you wish to file either an EEO or program complaint, please contact USDA through the Federal Relay Service at (800) 877-8339 or (800) 845-6136 (in Spanish).

If you have other disabilities and wish to file a program complaint, please see the contact information above. If you require alternative means of communication for

program information (e.g., Braille, large print, audiotape, etc.), please contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

Supplemental Nutrition Assistance Program

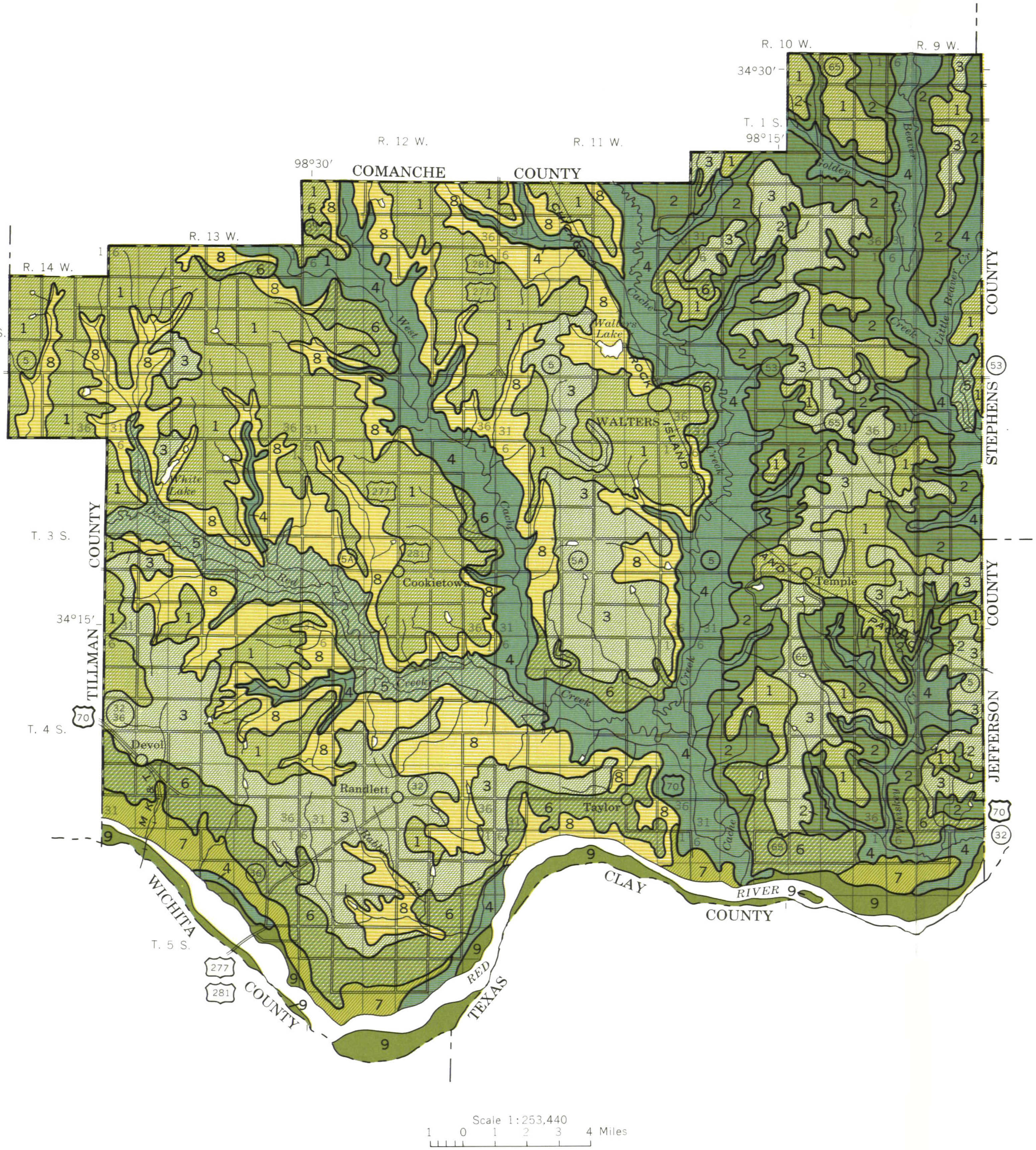
For additional information dealing with Supplemental Nutrition Assistance Program (SNAP) issues, call either the USDA SNAP Hotline Number at (800) 221-5689, which is also in Spanish, or the State Information/Hotline Numbers (http://directives.sc.egov.usda.gov/33085.wba).

All Other Inquiries

For information not pertaining to civil rights, please refer to the listing of the USDA Agencies and Offices (http://directives.sc.egov.usda.gov/33086.wba).

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
OKLAHOMA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP
COTTON COUNTY, OKLAHOMA

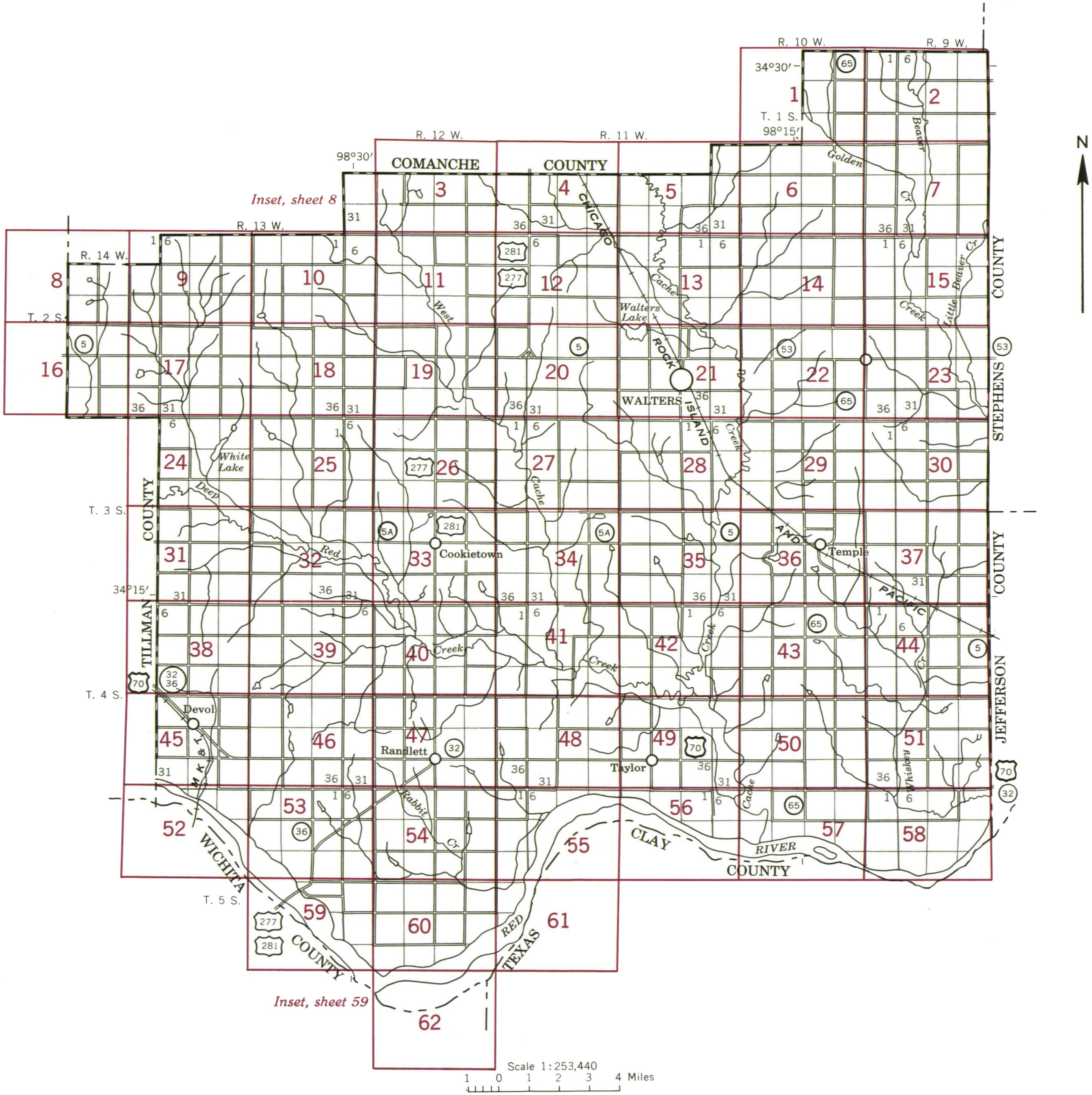


SOIL ASSOCIATIONS

1. Foard-Tillman association: Nearly level to gently sloping soils that have clayey subsoil; on uplands
2. Zaneis-Lucien association: Deep and shallow, moderately sloping soils of the uplands
3. Foard-Zaneis association: Nearly level to moderately sloping soils of the uplands, some with slickspots
4. Port-Yahola association: Loamy soils of the flood plains
5. Miller association: Clayey soils of the flood plains
6. Enterprise-Tipton-Lawton association: Loamy soils of the uplands
7. Pratt-Tivoli association: Sandy soils of the uplands
8. Vernon association: Red clay soils of the uplands
9. Lincoln association: Sandy soils of the flood plains

April 1962

INDEX TO MAP SHEETS
COTTON COUNTY, OKLAHOMA



SOIL LEGEND

The first capital letter is the initial one of the soil name. A second capital letter, if used, shows the slope. A final number, 2 or 3, shows that the soil is eroded or severely eroded.

SYMBOL	NAME
Ba	Breaks - alluvial land complex
Bd	Broken alluvial land
ChA	Chickasha loam, 0 to 1 percent slopes
ErA	Enterprise very fine sandy loam, 0 to 1 percent slopes
ErB	Enterprise very fine sandy loam, 1 to 3 percent slopes
ErC	Enterprise very fine sandy loam, 3 to 5 percent slopes
ErD	Enterprise very fine sandy loam, 5 to 8 percent slopes
Es	Eroded clayey land
FoA	Foard silt loam, 0 to 1 percent slopes
FsA	Foard-slickspot complex, 0 to 1 percent slopes
FsB	Foard-slickspot complex, 1 to 3 percent slopes
FtB	Foard and Tillman silt loams, 1 to 3 percent slopes
LaA	Lawton loam, 0 to 1 percent slopes
LaB	Lawton loam, 1 to 3 percent slopes
LaC	Lawton loam, 3 to 5 percent slopes
LaC2	Lawton loam, 3 to 5 percent slopes, eroded
Ls	Lincoln soils
Lz	Lucien-Zaneis-Vernon complex
Mr	Miller clay
Po	Port clay loam
Pr	Port loam
Ps	Port-slickspot complex
PtB	Pratt loamy fine sand, undulating
PvC	Pratt and Tivoli soils, rolling
Rg	Rough broken land
ShB	Shellabarger loamy sand, 0 to 4 percent slopes
TaB	Tillman silt loam, 1 to 3 percent slopes
TpA	Tipton loam, 0 to 1 percent slopes
TpB	Tipton loam, 1 to 3 percent slopes
Ts	Treadway soils
VcB	Vernon clay, 1 to 3 percent slopes
VsC	Vernon soils, 3 to 5 percent slopes
VsE	Vernon soils, 5 to 12 percent slopes
Wa	Waurika silt loam
Ya	Yahola fine sandy loam
ZaB	Zaneis loam, 1 to 3 percent slopes
ZaC	Zaneis loam, 3 to 5 percent slopes
ZaC2	Zaneis loam, 3 to 5 percent slopes, eroded
Zn3	Zaneis soil, severely eroded
ZsB	Zaneis-slickspot complex, 1 to 3 percent slopes

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Dual
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail, foot
- Railroad
- Ferries
- Ford
- Grade
- R. R. over
- R. R. under
- Tunnel

Buildings
- School
- Church
- Station

Mines and Quarries

Mine dump

Pits, gravel or other

Power lines

Pipe lines

Cemeteries

Dams

Levees

Tanks

Oil wells

BOUNDARIES

- National or state
- County
- Township, U. S.
- Section line, corner
- Reservation
- Land grant

DRAINAGE

Streams
- Perennial
- Intermittent, unclass.

Canals and ditches — CANAL, DITCH

Lakes and ponds
- Perennial
- Intermittent

Wells — flowing

Springs

Marsh

Wet spot

RELIEF

Escarpments
- Bedrock
- Other

Prominent peaks

Depressions — Large, Small
- Crossable with tillage implements
- Not crossable with tillage implements
- Contains water most of the time

SOIL SURVEY DATA

- Soil boundary and symbol — Dx
- Gravel
- Stones
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gullies

Soil map constructed 1962 by Cartographic Division, Soil Conservation Service, USDA, from 1957 aerial photographs. Controlled mosaic based on Oklahoma plane coordinate system, south zone, Lambert conformal conic projection, 1927 North American datum.

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

This map is one of a set compiled in 1962 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Oklahoma Agricultural Experiment Station.

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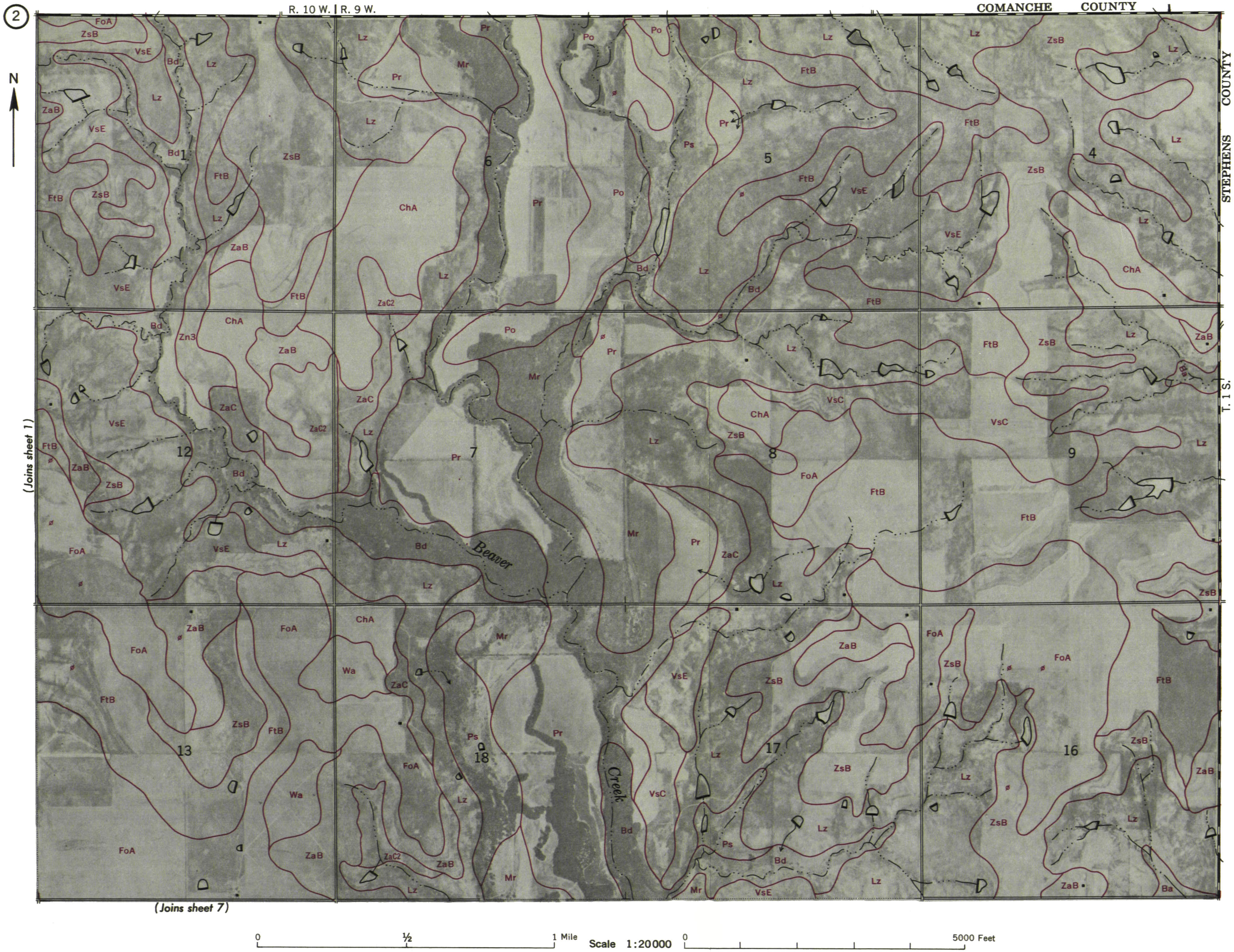
2
R. 10 W.
R. 9 W.
COMANCHE COUNTY
STEPHENS COUNTY
T. 1 S.
N
(Joins sheet 1)
(Joins sheet 7)
Beaver
Creek
1
4
5
6
7
8
9
12
13
16
17
18
0
½
1 Mile
Scale 1:20000
0
5000 Feet

3

N

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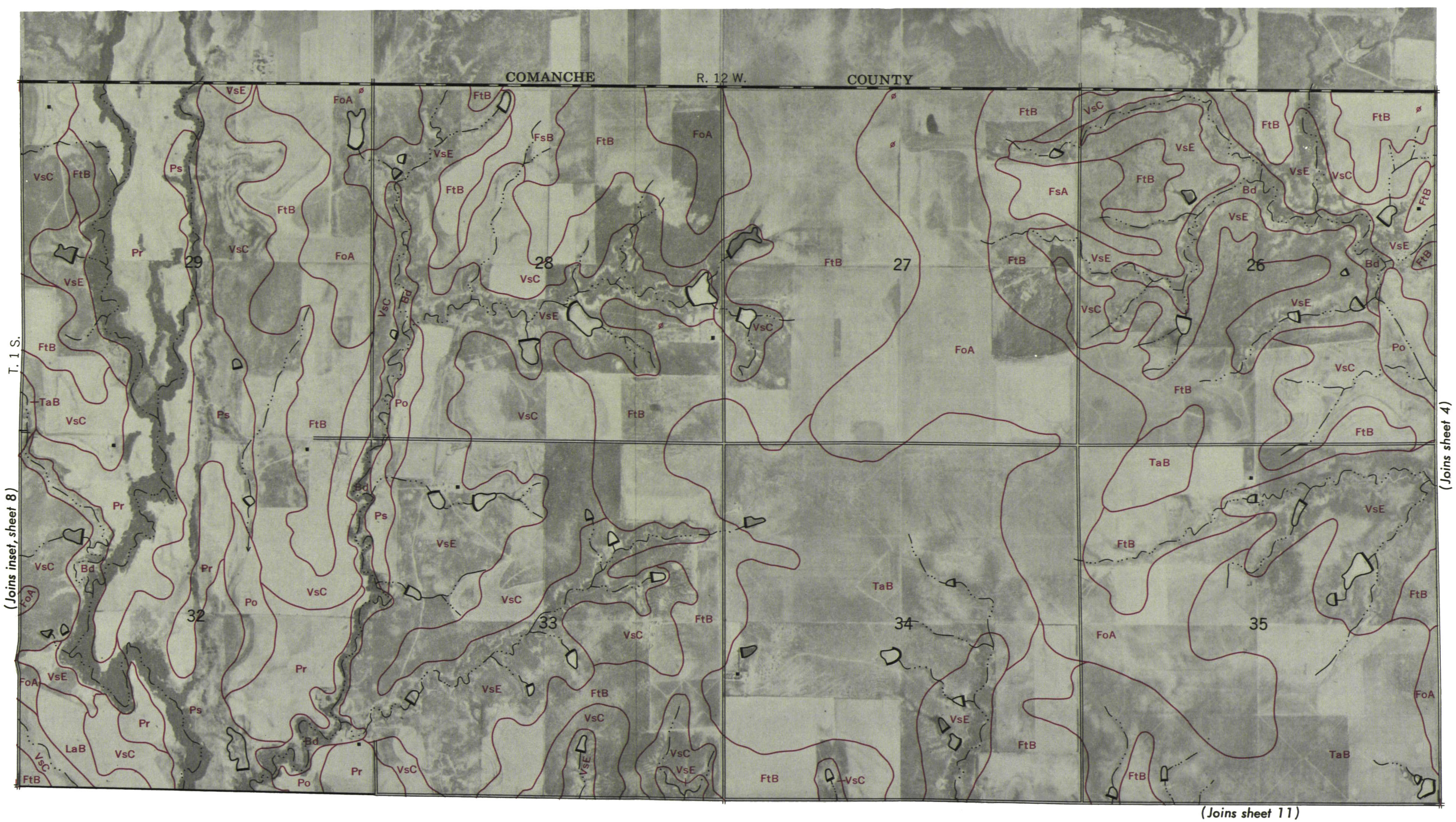

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

4


N
R. 12 W.
R. 11 W.
COMANCHE COUNTY
CHICAGO ROCK ISLAND AND PACIFIC
T. 1 S.
(Joins sheet 3)
(Joins sheet 5)
(Joins sheet 12)
25
30
29
28
36
31
32
33
0
½
1 Mile
Scale 1:20000
0
5000 Feet

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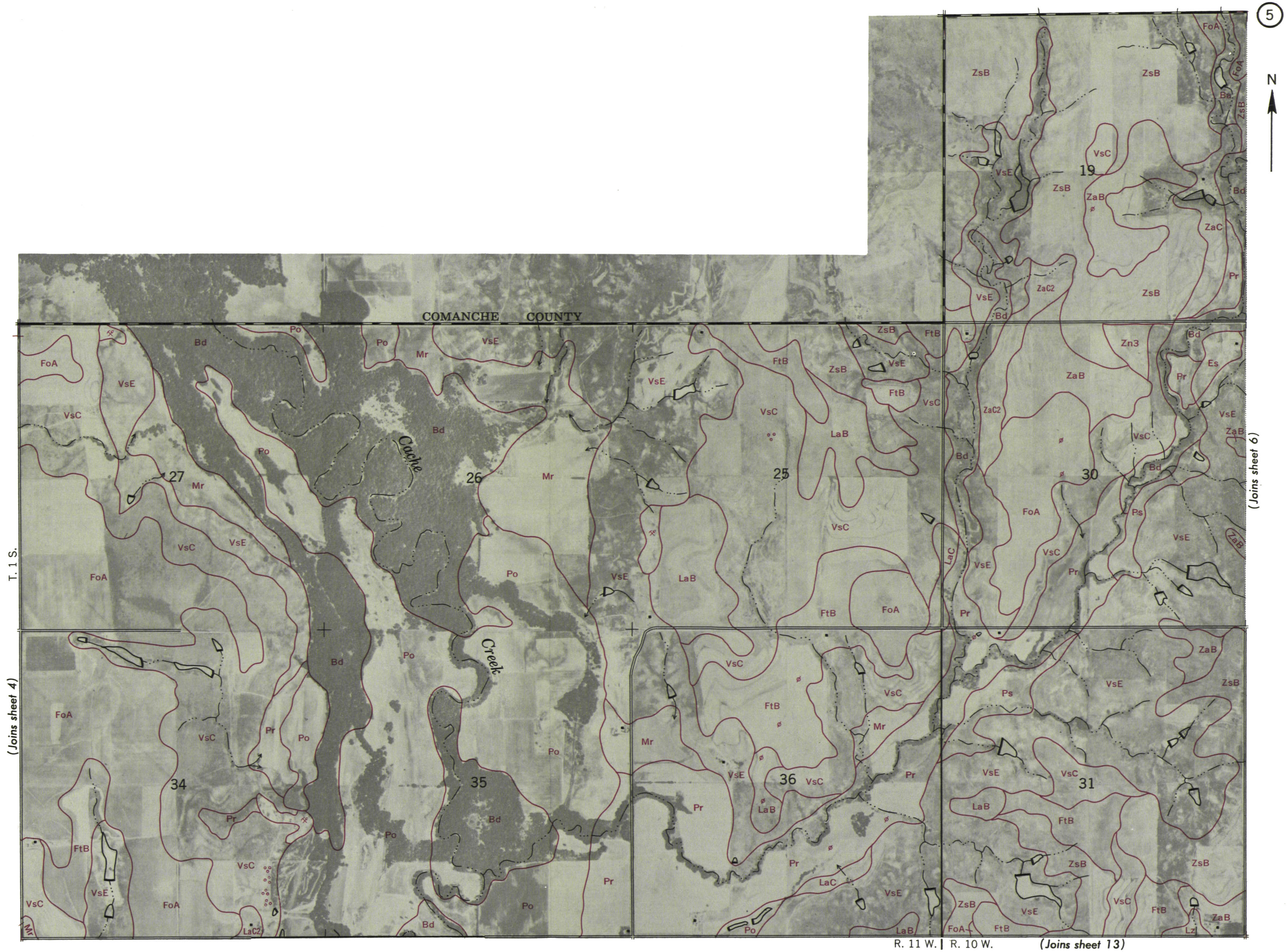
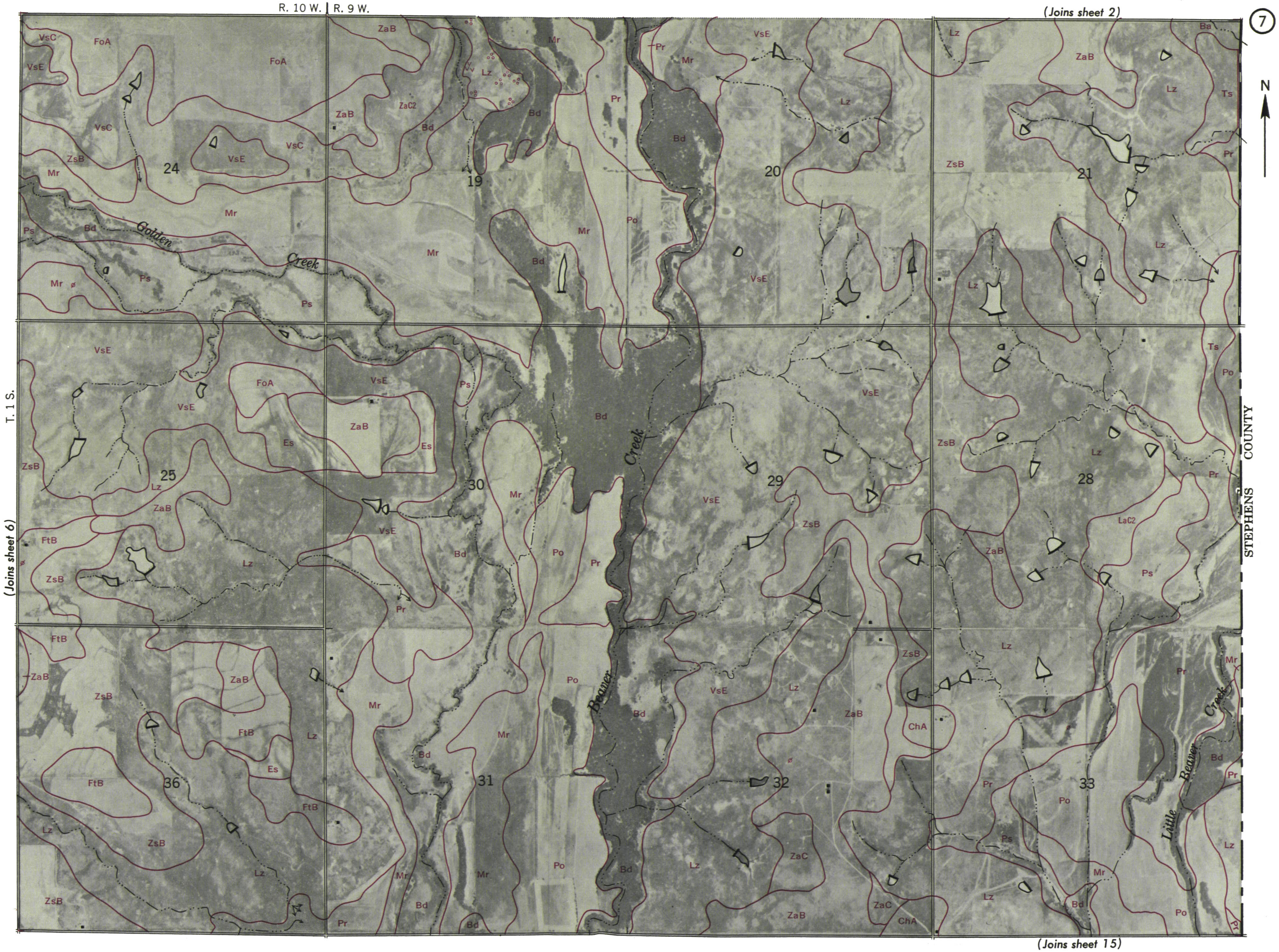


0 ½ 1 Mile Scale 1:20000 0 5000 Feet


6
COMANCHE COUNTY
R. 10 W.
(Joins sheet 1)
N
(Joins sheet 5)
T. 1 S.
(Joins sheet 7)
(Joins sheet 14)
Golden Creek
20
21
22
23
29
28
27
26
32
33
34
35
65
0 ½ 1 Mile
Scale 1:20000
0 5000 Feet



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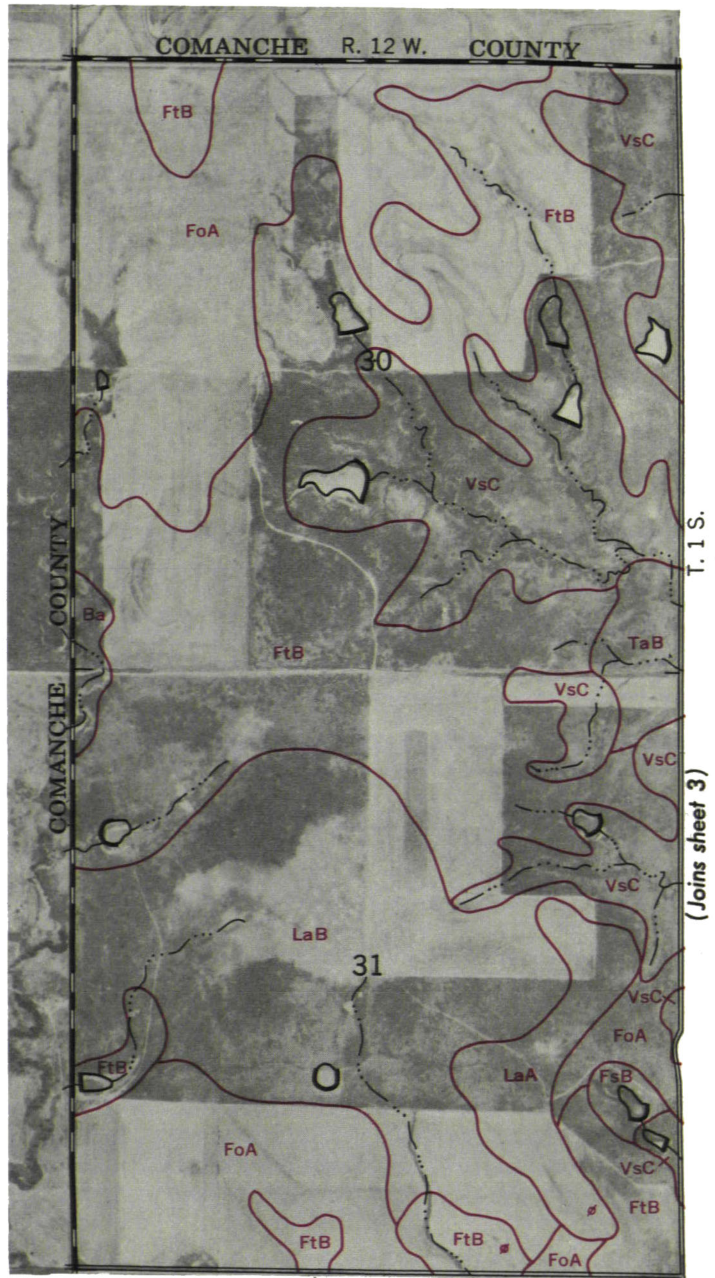
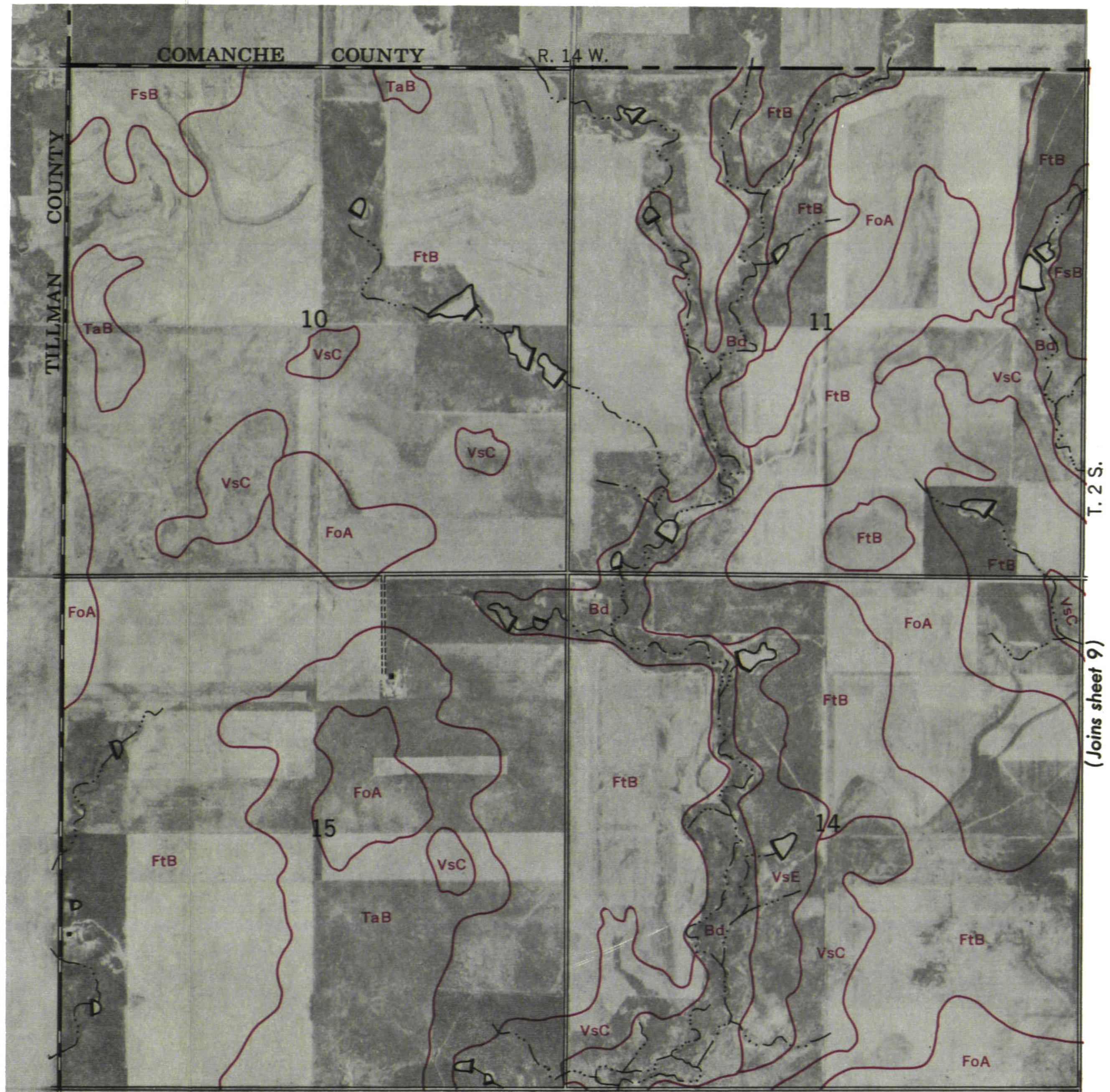
0 ½ 1 Mile Scale 1:20000 0 5000 Feet

8

N



(Joins sheet 10)



(Joins sheet 16)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

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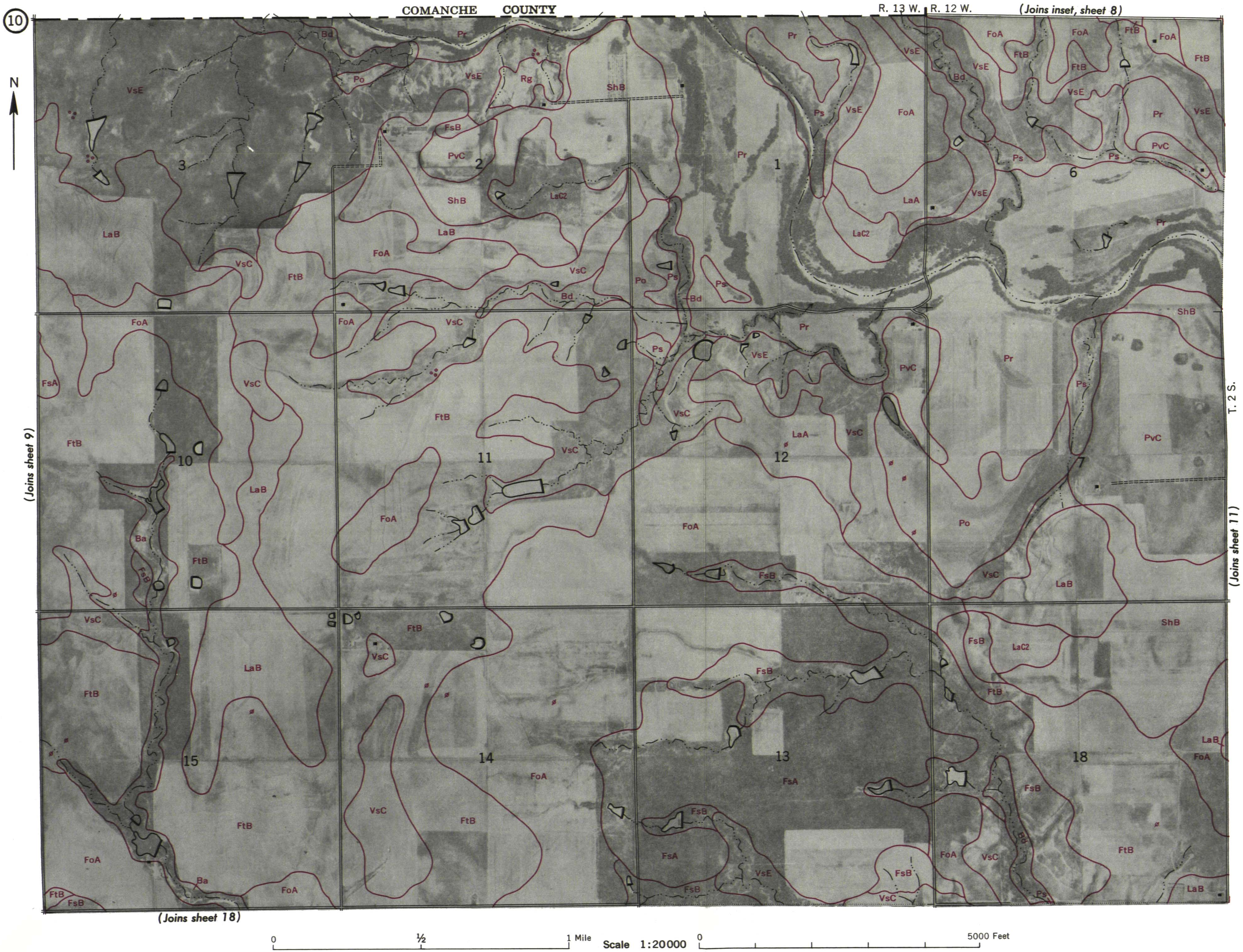
10
COMANCHE COUNTY
R. 13 W.
R. 12 W.
(Joins inset, sheet 8)
N
(Joins sheet 9)
(Joins sheet 11)
T. 2 S.
(Joins sheet 18)
1
2
3
6
7
10
11
12
13
14
15
18
VsE
Bd
Pr
Po
Rg
ShB
FsB
PvC
LaB
LaC2
FoA
FtB
VsC
Ps
LaA
FsA
Ba
FsA
Scale 1:20000
0
½
1 Mile
5000 Feet

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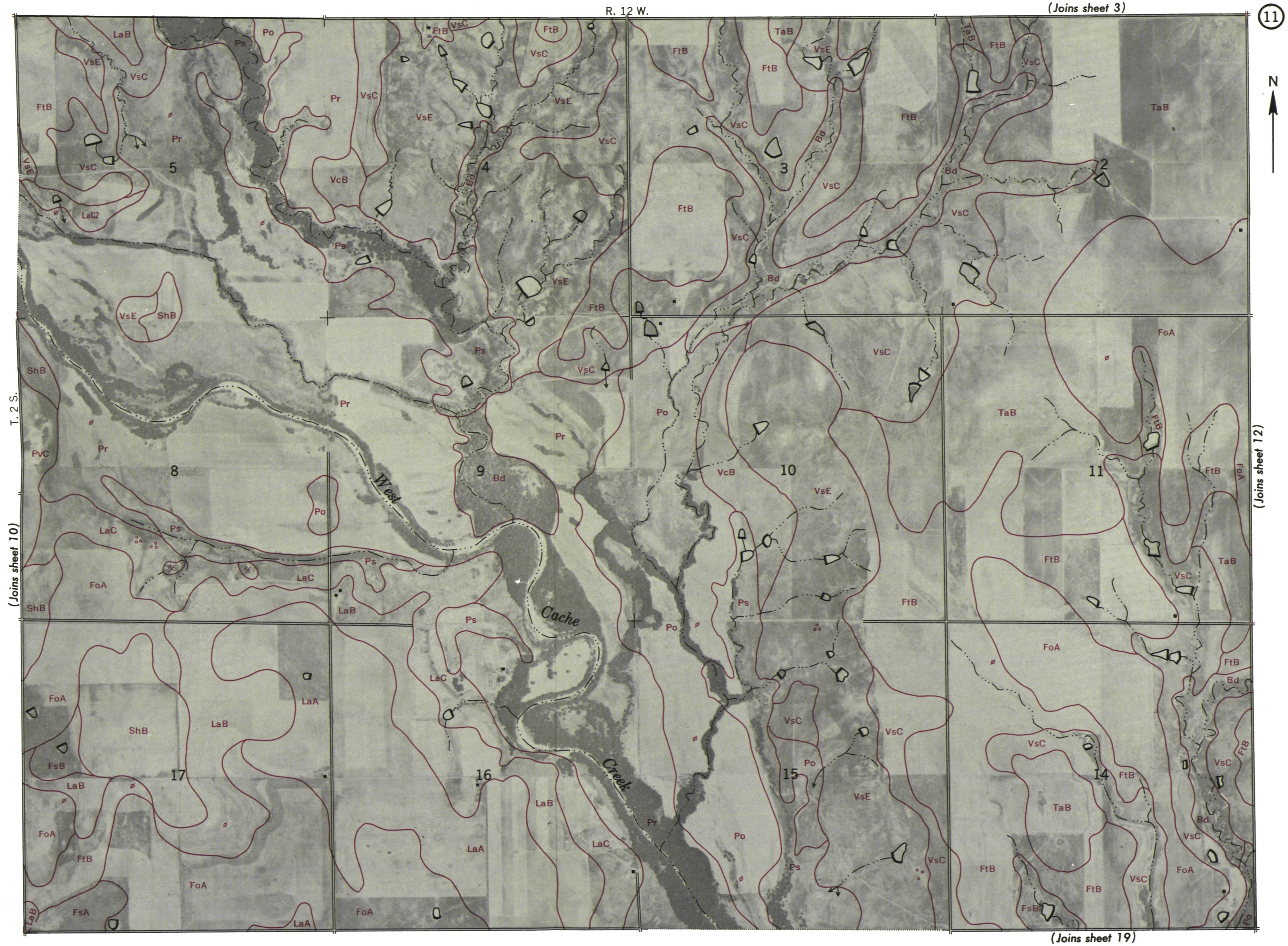
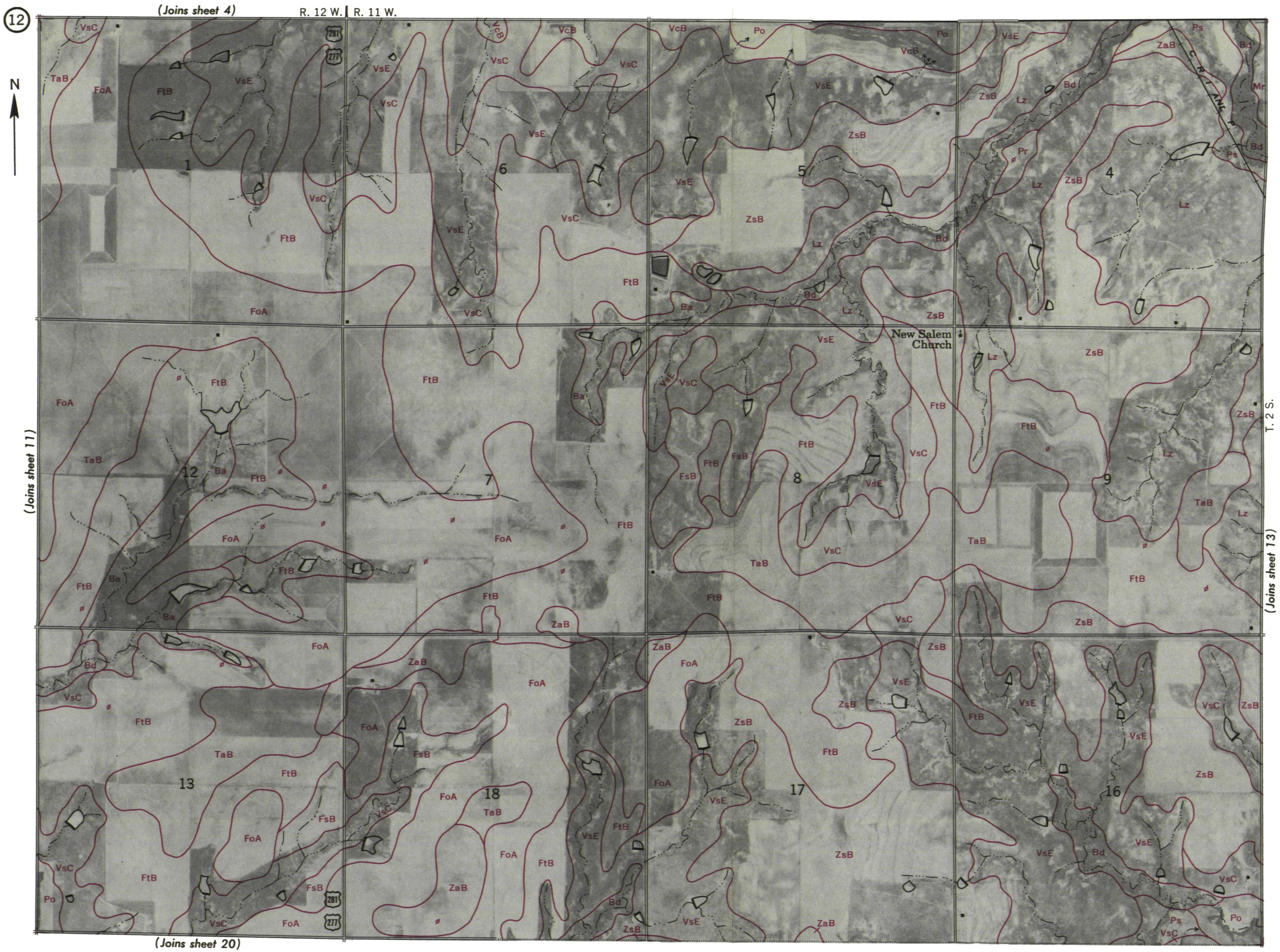


0 ½ 1 Mile Scale 1:20000 0 5000 Feet

COTTON COUNTY, OKLAHOMA — SHEET NUMBER 12



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

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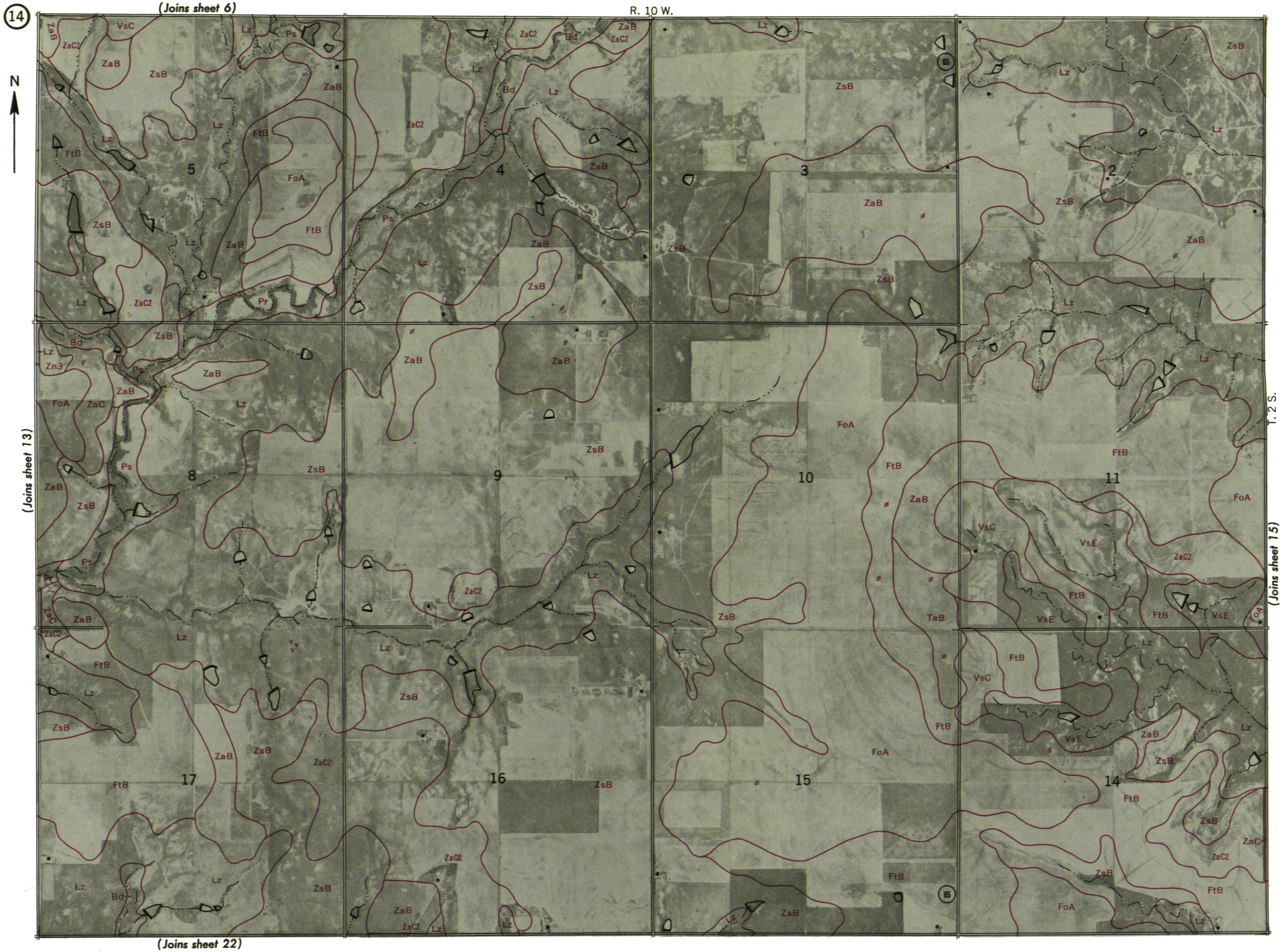
0 ½ 1 Mile Scale 1:20000 0 5000 Feet


14
(Joins sheet 6)
R. 10 W.
N
(Joins sheet 13)
(Joins sheet 15)
T. 2 S.
(Joins sheet 22)
0
½
1 Mile
Scale 1:20000
0
5000 Feet

COTTON COUNTY, OKLAHOMA — SHEET NUMBER 15

This map is one of a set compiled in 1962 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Oklahoma Agricultural Experiment Station.

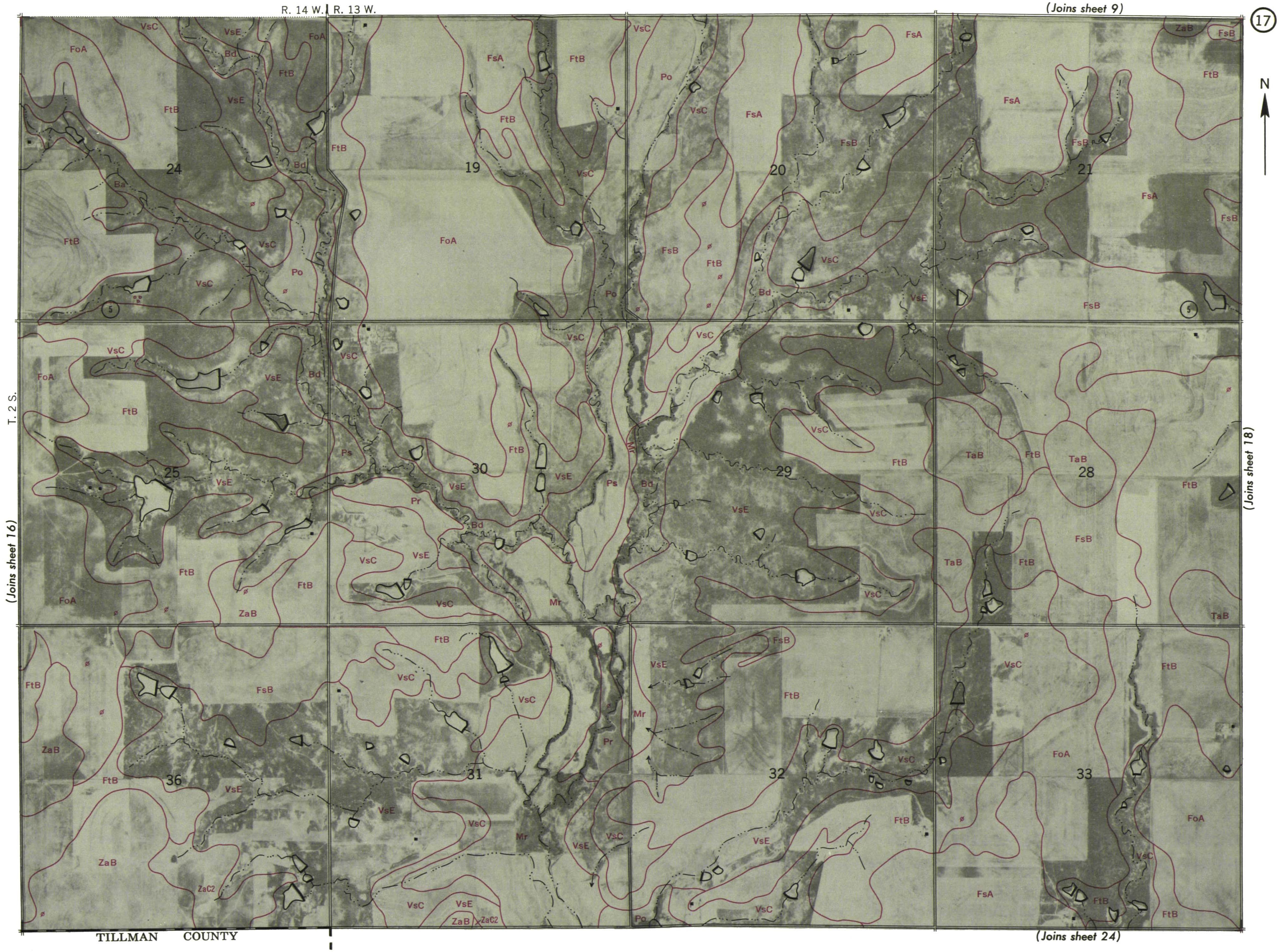
Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

16

N

0 ½ 1 Mile Scale 1:20000 0 5000 Feet



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

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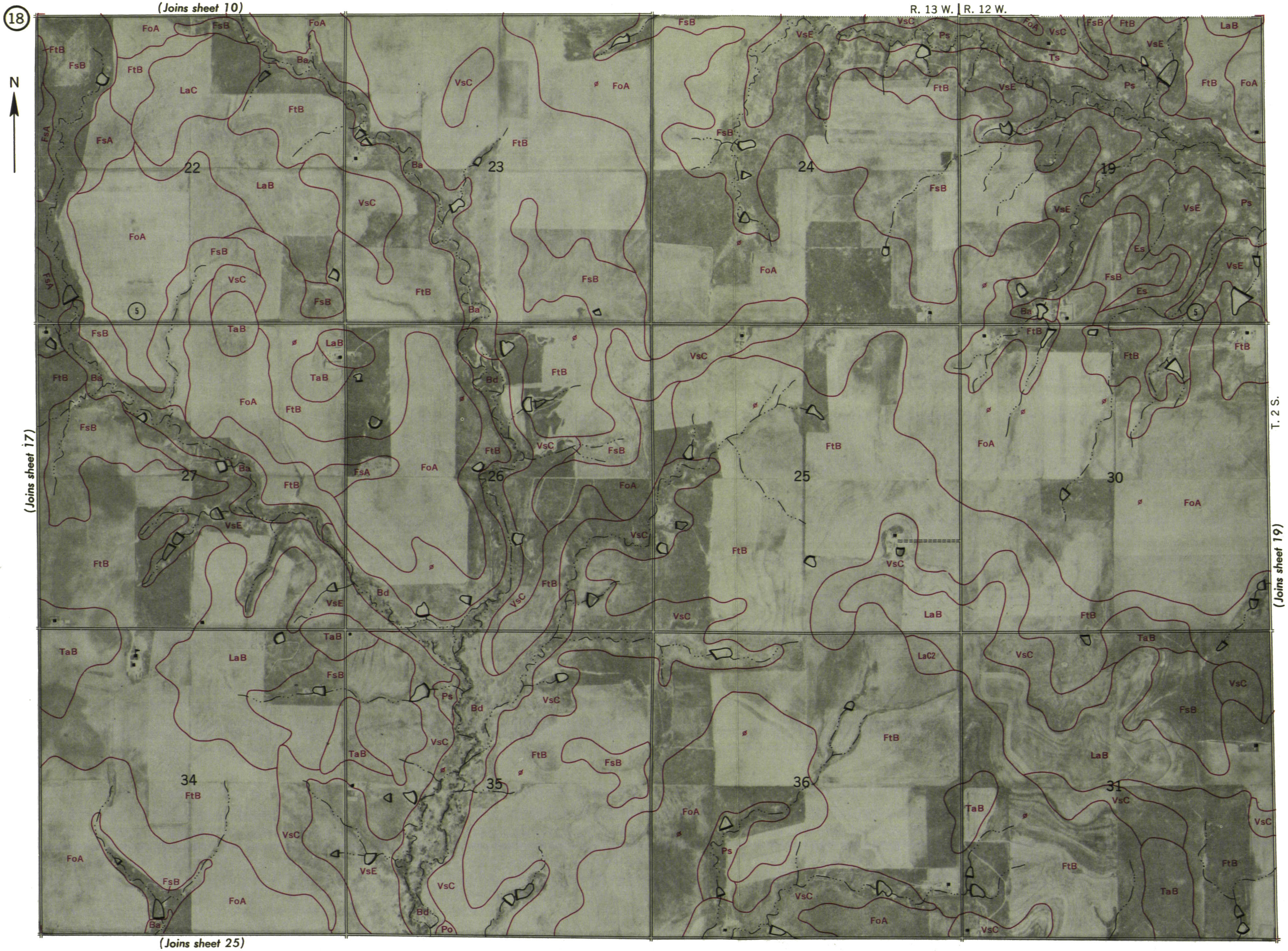
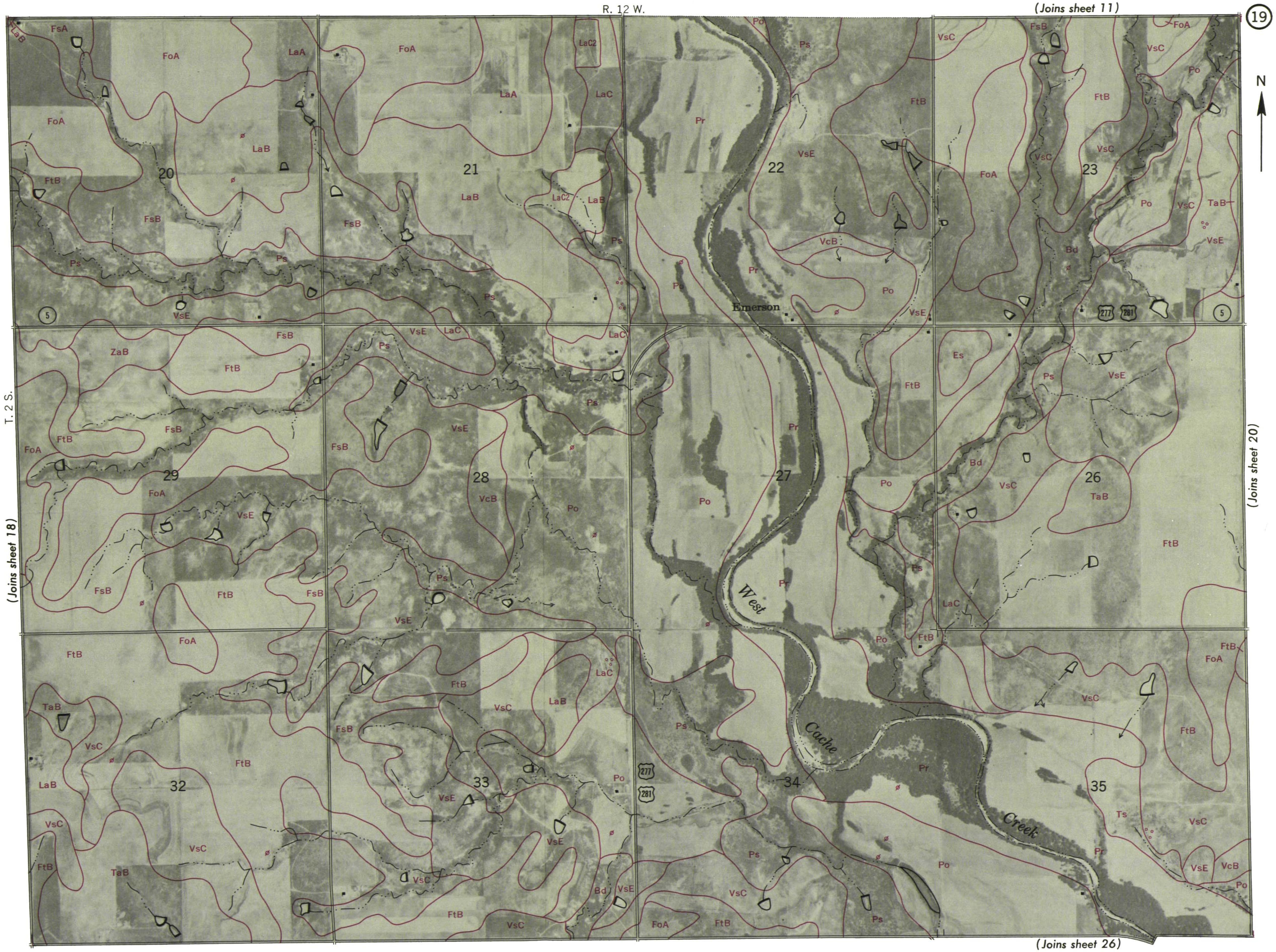
Range, township, and section corners shown on this map are indefinite.

COTTON COUNTY, OKLAHOMA — SHEET NUMBER 18



0 ½ 1 Mile Scale 1:20000 0 5000 Feet



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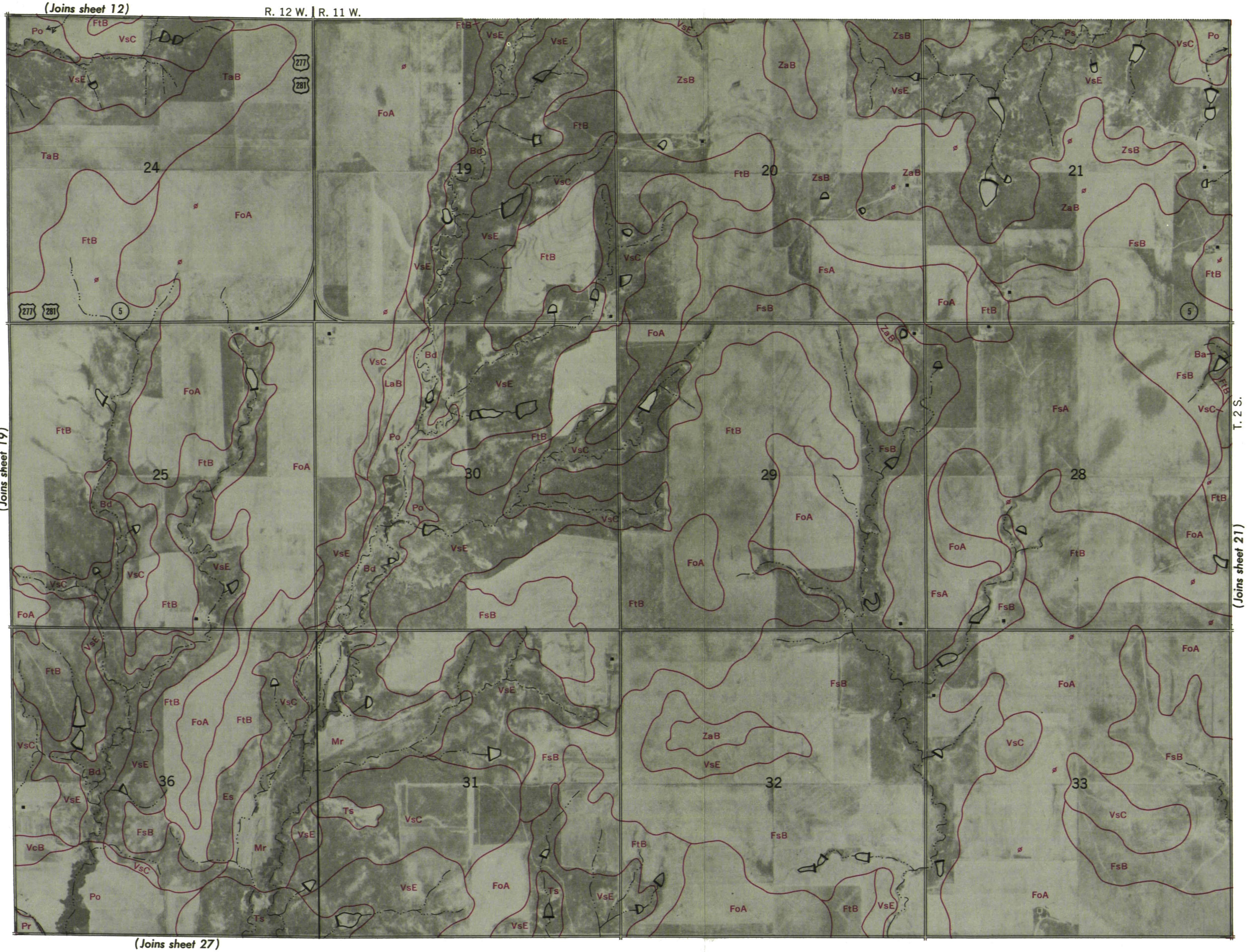
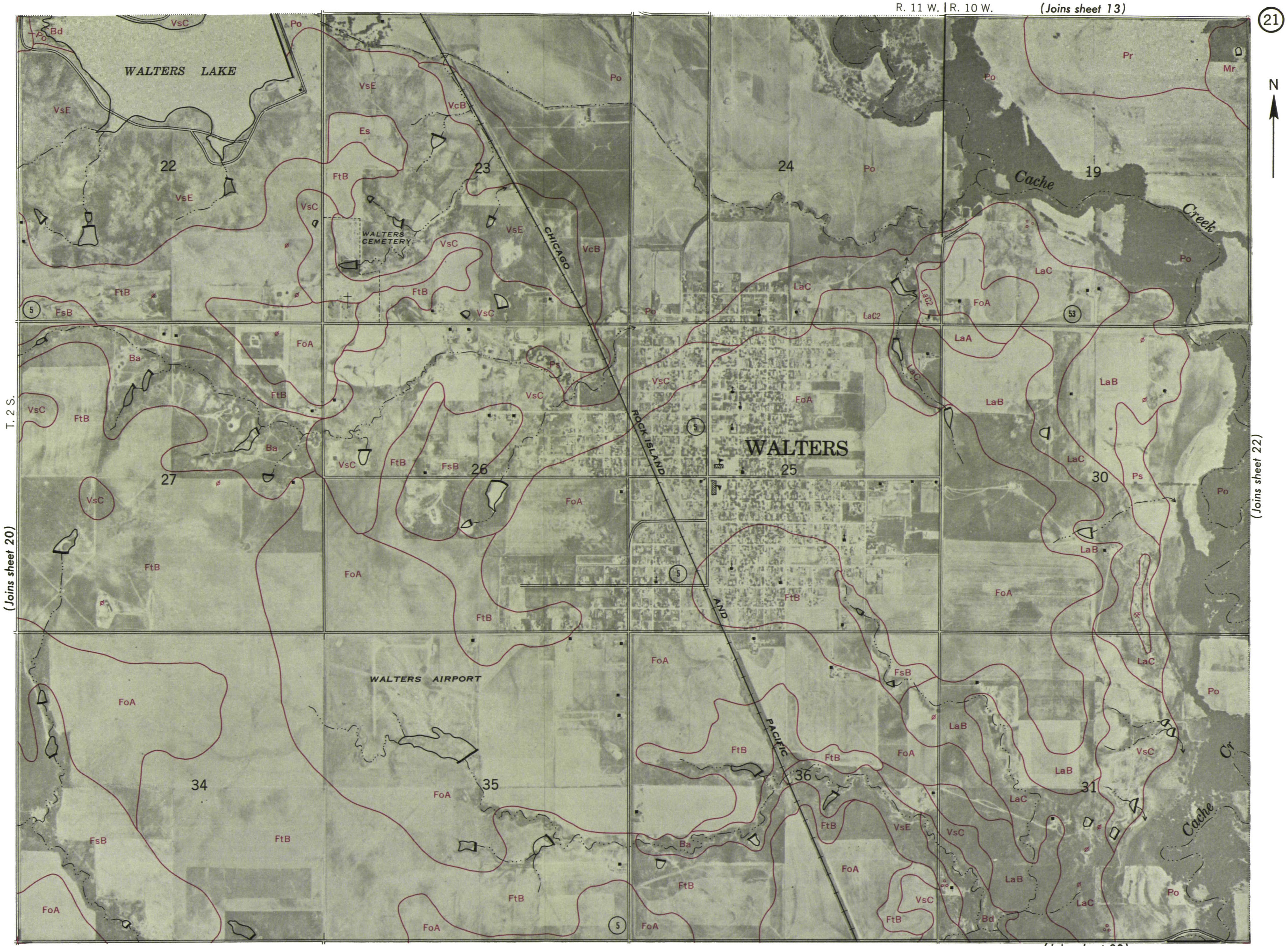
0 ½ 1 Mile **Scale 1:20000** 0 5000 Feet

20



0 ½ 1 Mile Scale 1:20000 0 5000 Feet



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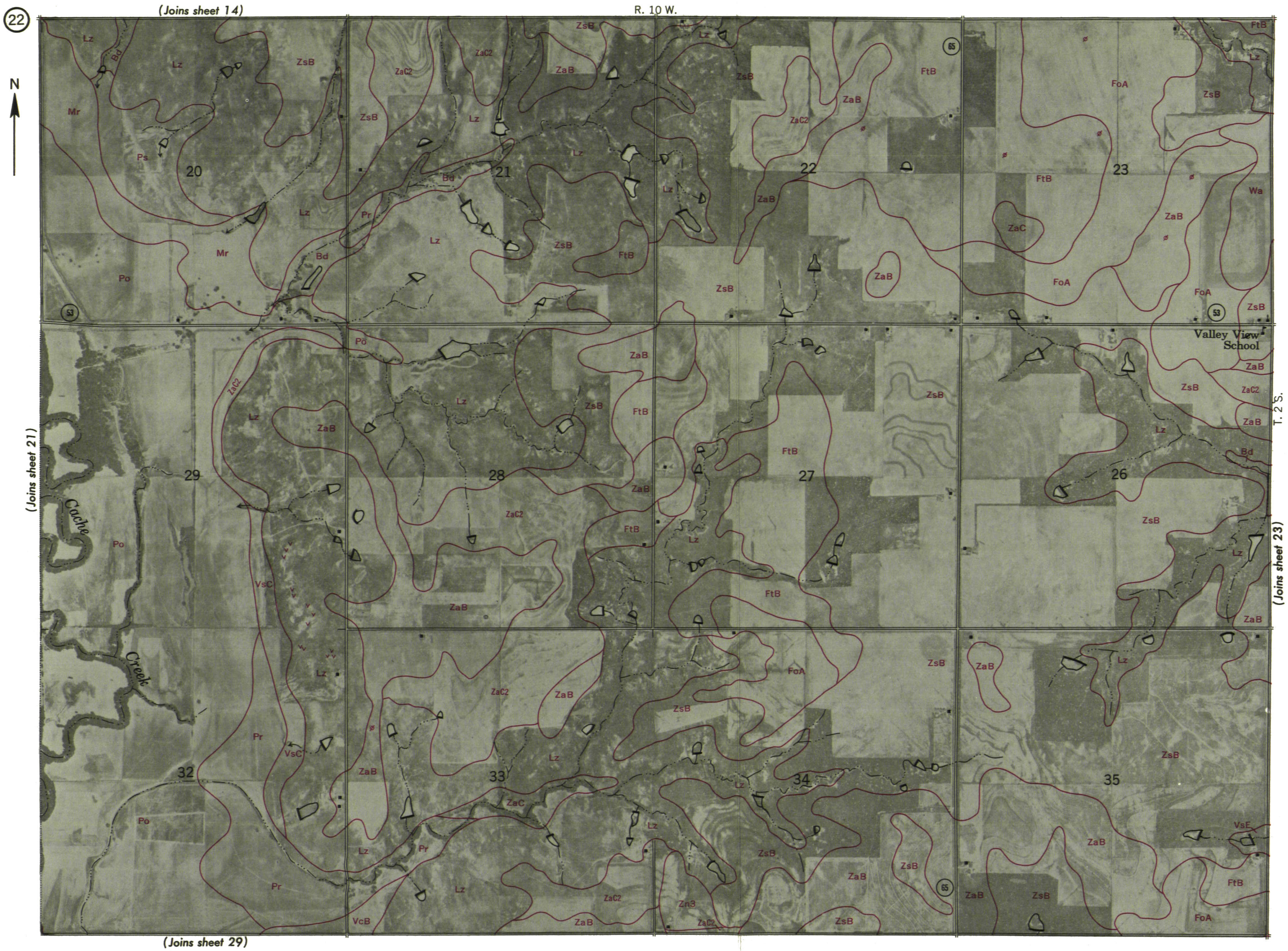
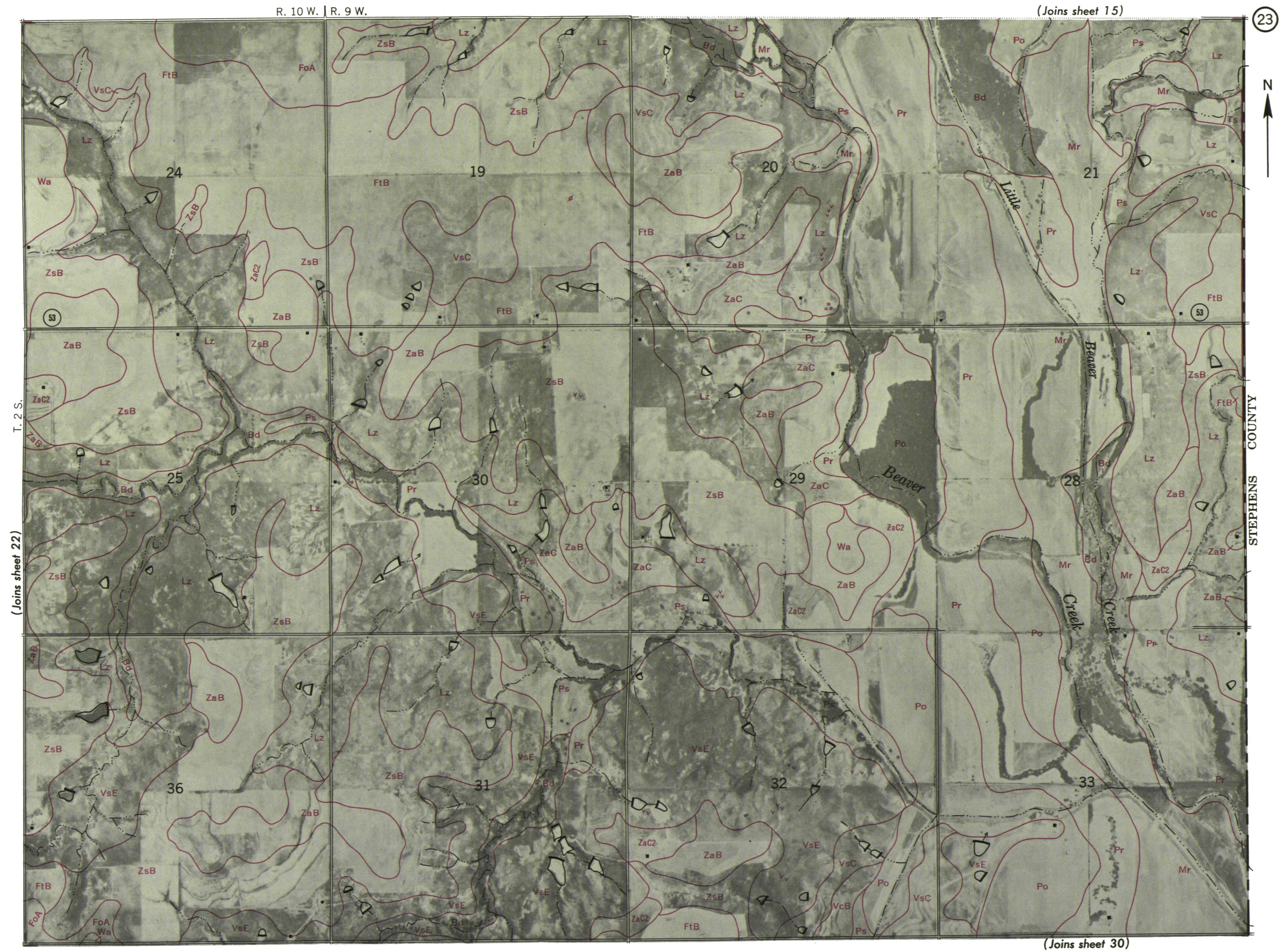
0 ½ 1 Mile Scale 1:20000 0 5000 Feet



0 ½ 1 Mile Scale 1:20000 0 5000 Feet



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

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COTTON COUNTY, OKLAHOMA — SHEET NUMBER 24

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

COTTON COUNTY, OKLAHOMA — SHEET NUMBER 25

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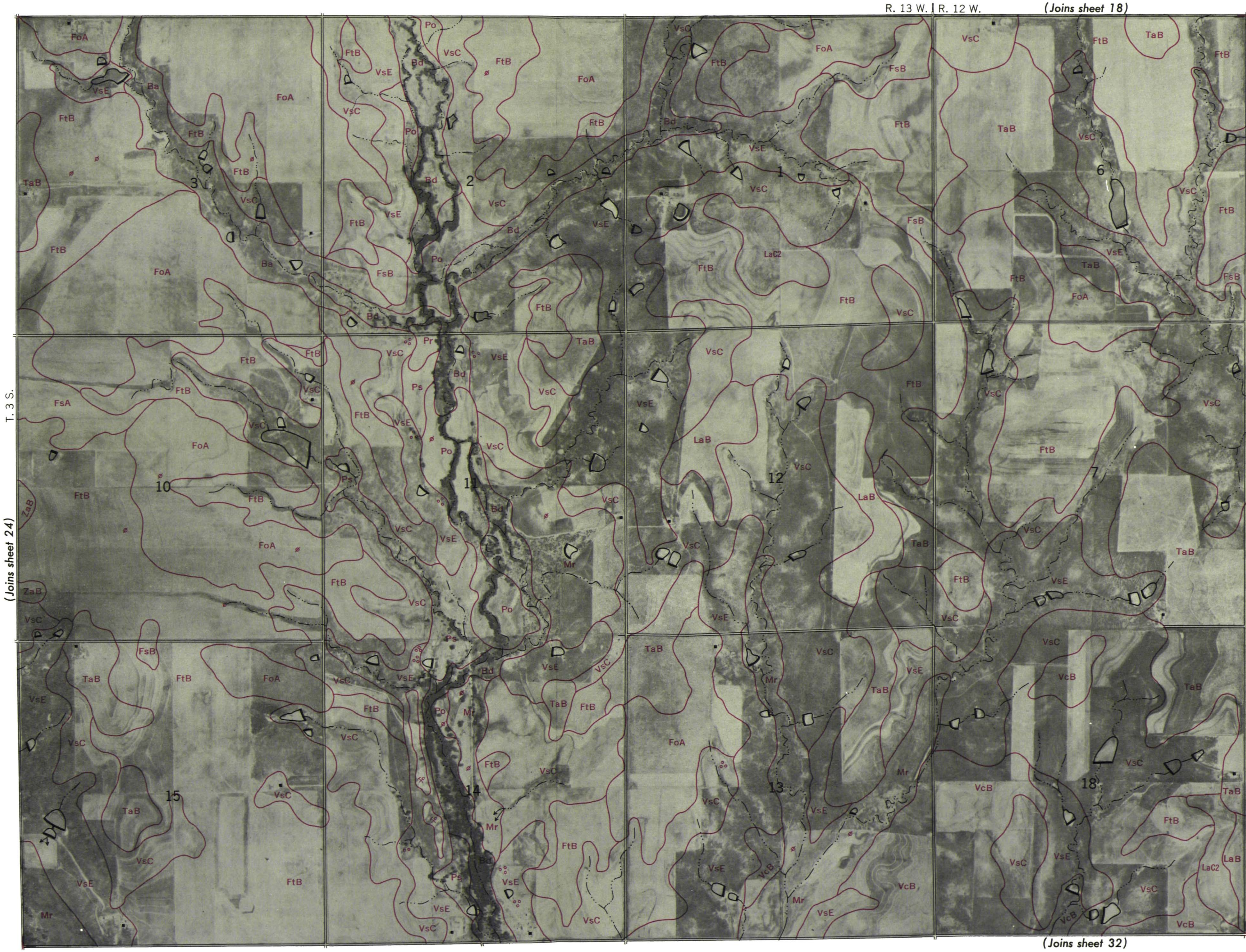
Range, township, and section corners shown on this map are indefinite.



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

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0 ½ 1 Mile Scale 1:20000 0 5000 Feet

COTTON COUNTY, OKLAHOMA — SHEET NUMBER 29

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

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0 ½ 1 Mile Scale 1:20000 0 5000 Feet

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

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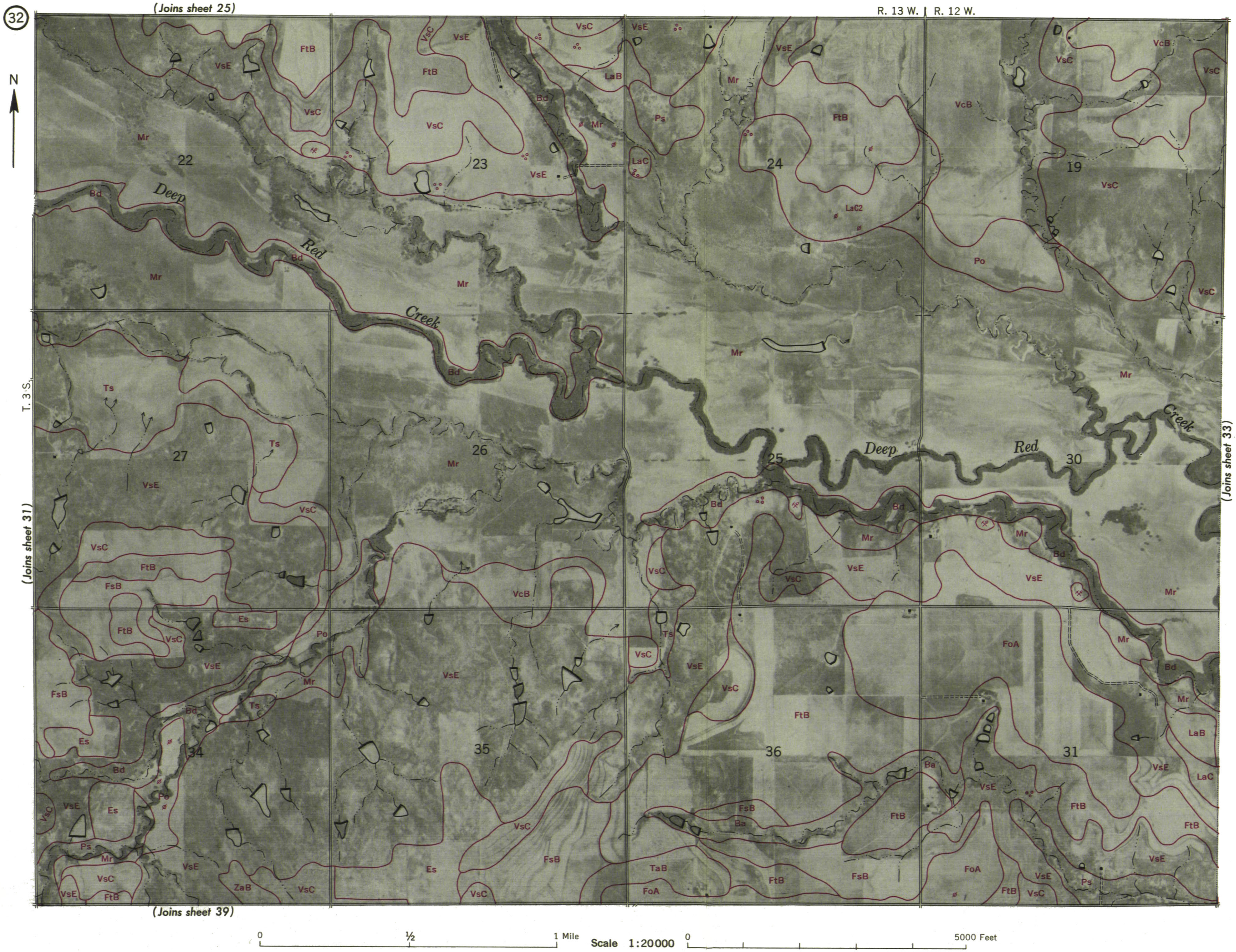
COTTON COUNTY, OKLAHOMA — SHEET NUMBER 32



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

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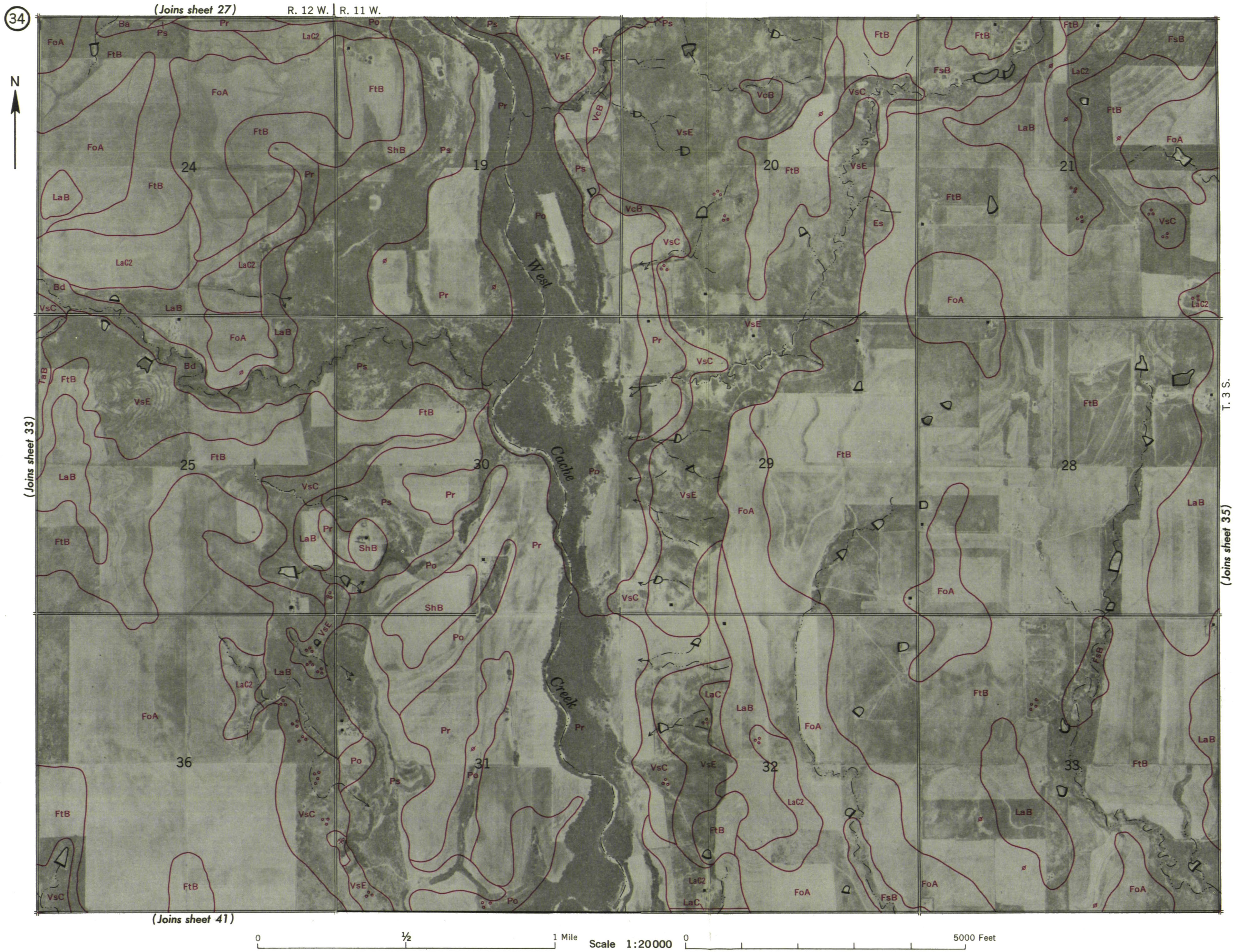
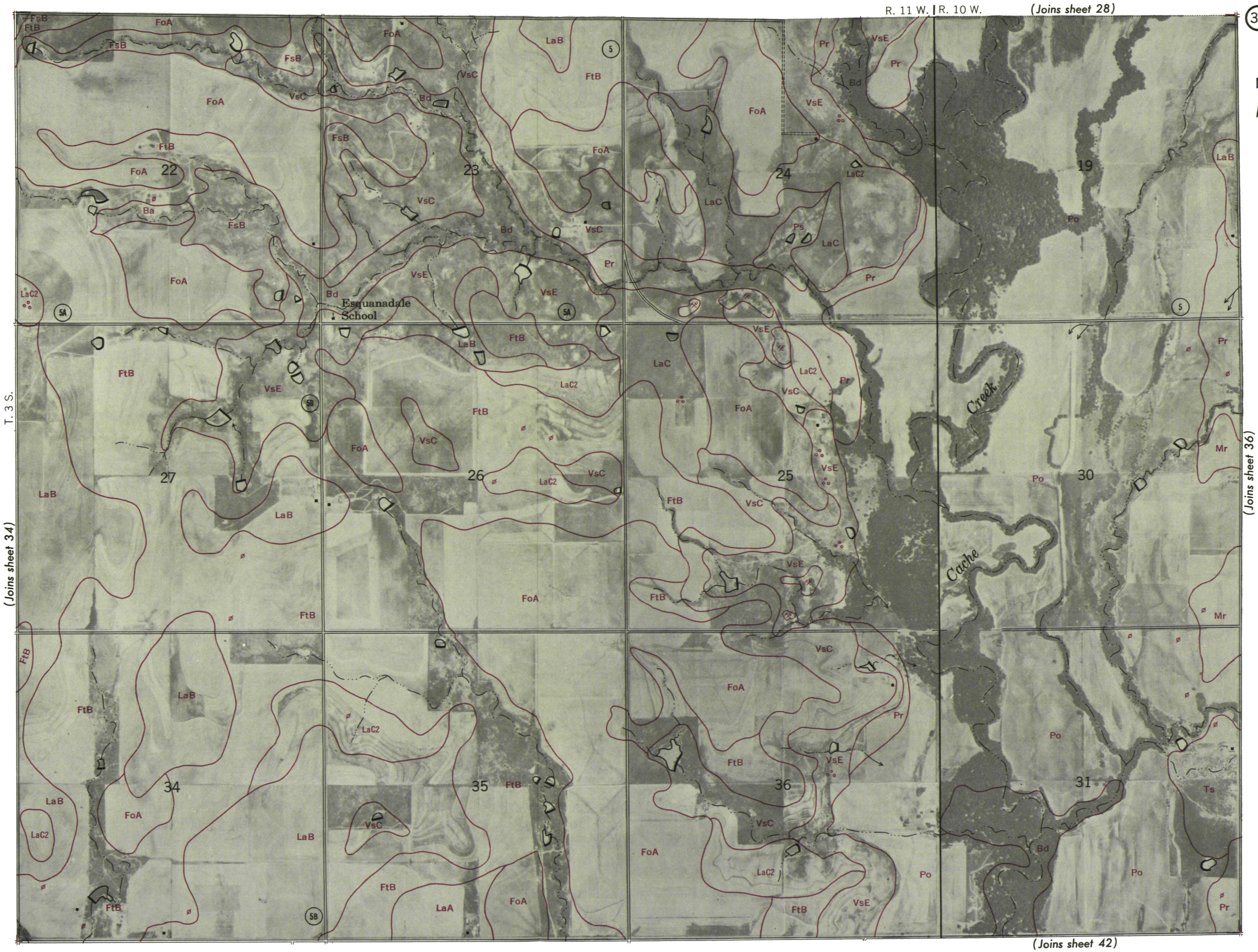
Range, township, and section corners shown on this map are indefinite.


34
(Joins sheet 27)
R. 12 W. R. 11 W.
N
(Joins sheet 33)
(Joins sheet 35)
T. 3 S.
(Joins sheet 41)
West Cache Creek
24
19
20
21
25
30
29
28
36
31
32
33
0 ½ 1 Mile Scale 1:20000 0 5000 Feet



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

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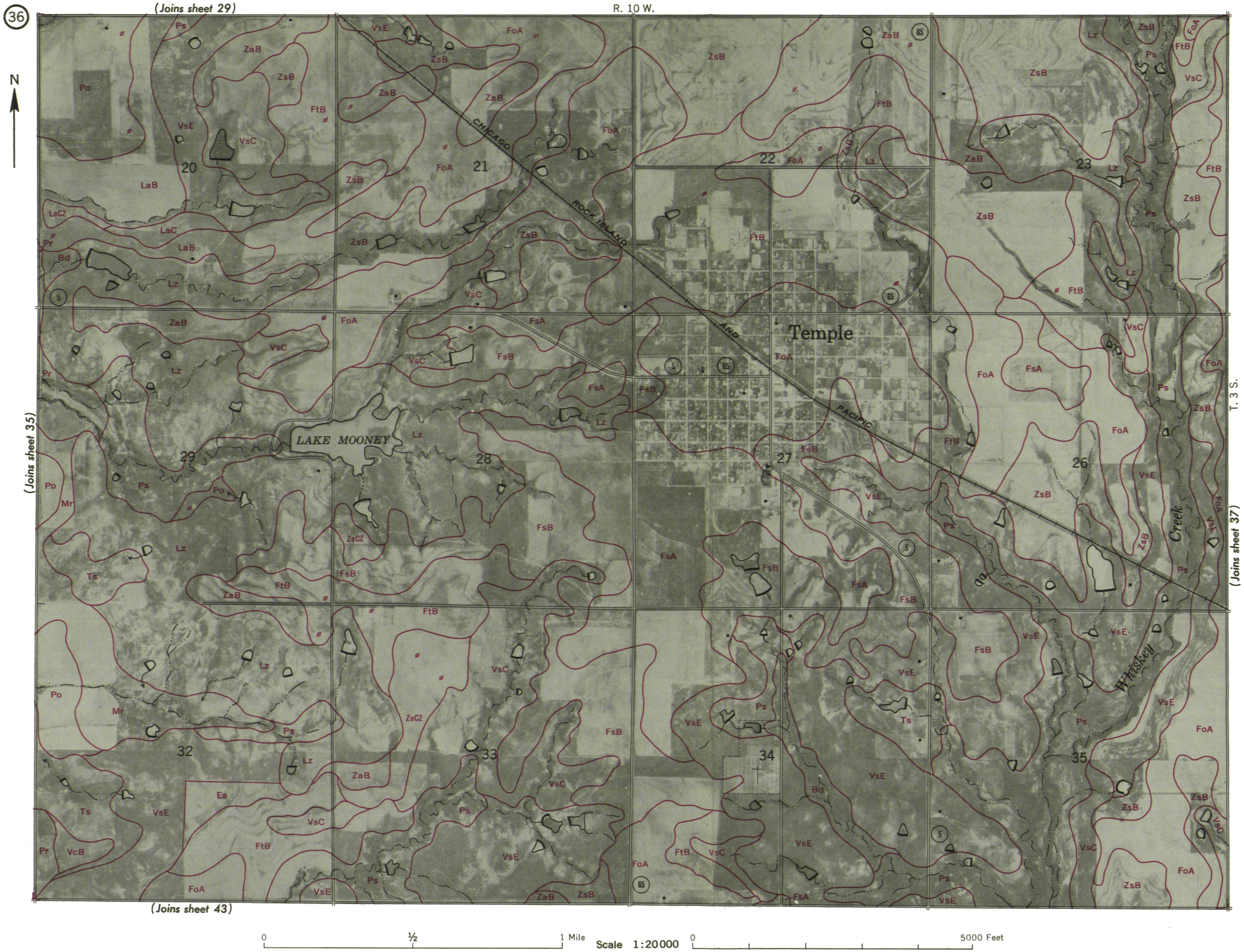
COTTON COUNTY, OKLAHOMA — SHEET NUMBER 36



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

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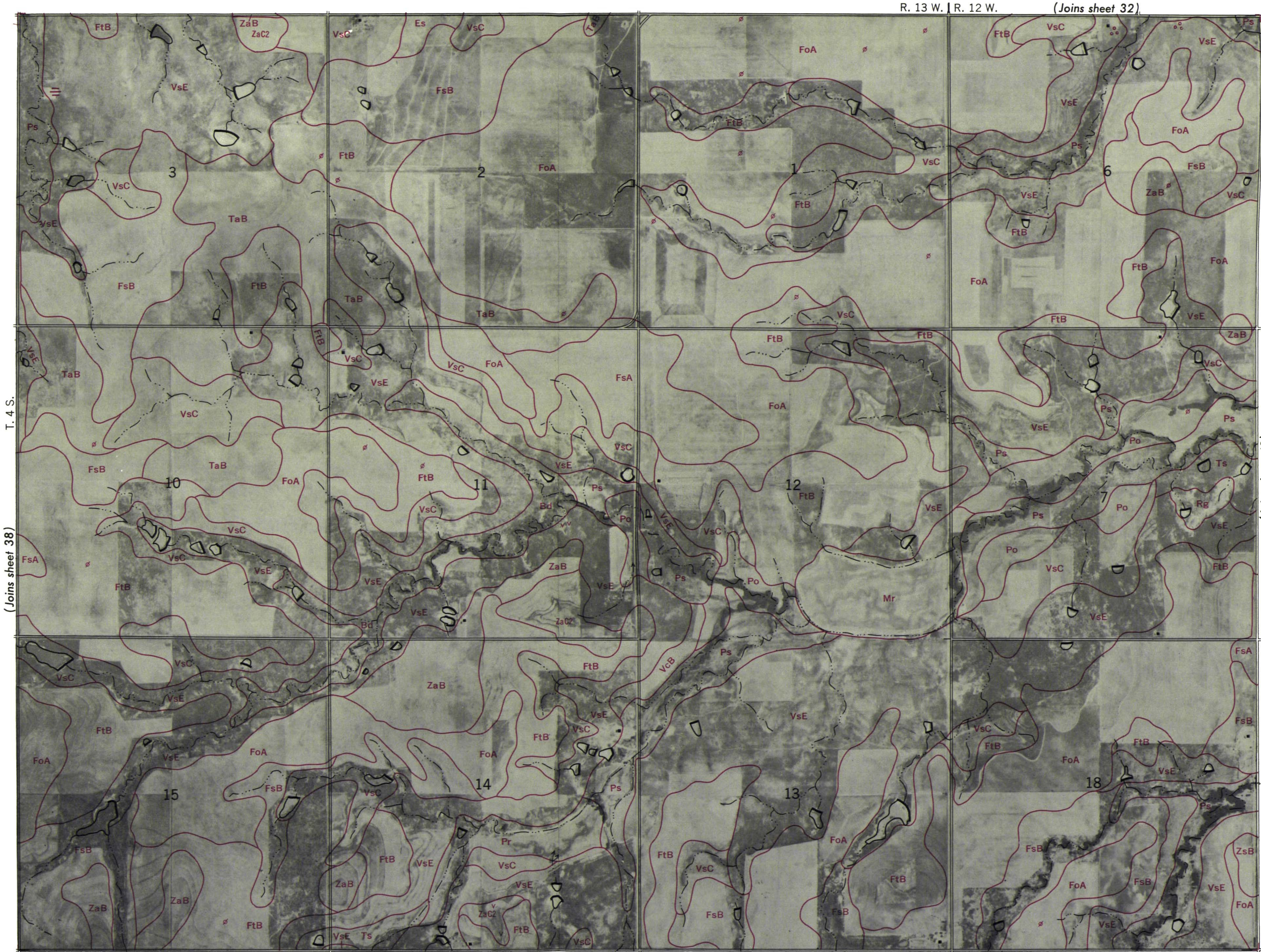
Range, township, and section corners shown on this map are indefinite.


38
N
(Joins sheet 31)
R. 13 W.
TILLMAN COUNTY
T. 4 S.
(Joins sheet 39)
(Joins sheet 45)
6
5
4
7
8
9
18
17
16
FsB
ZaB
FsA
VsE
Ps
FtB
ZaC
Es
FoA
ZaC2
VsC
FoA
TpB
70
36
32
M K T
0
½
1 Mile
Scale 1:20000
0
5000 Feet



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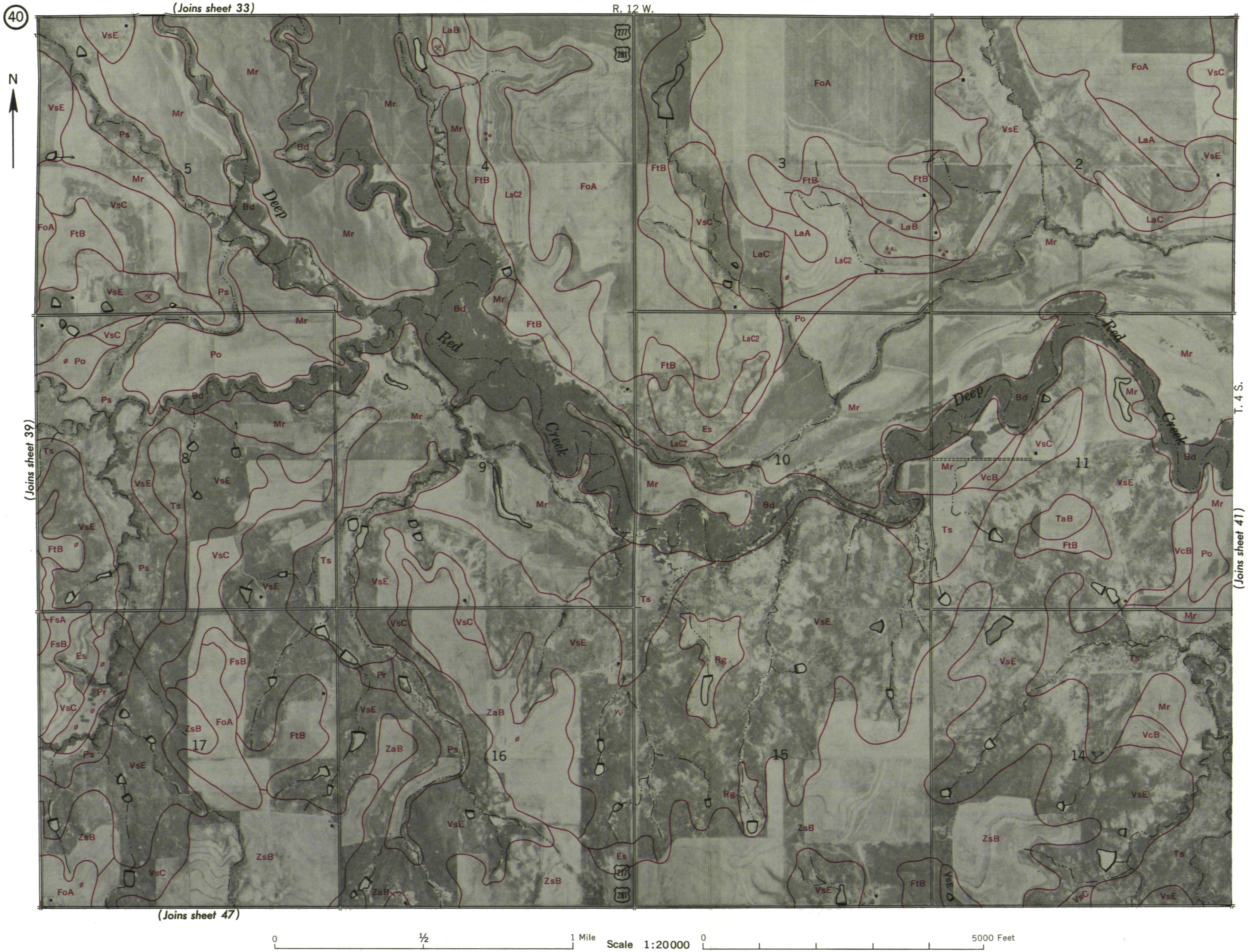
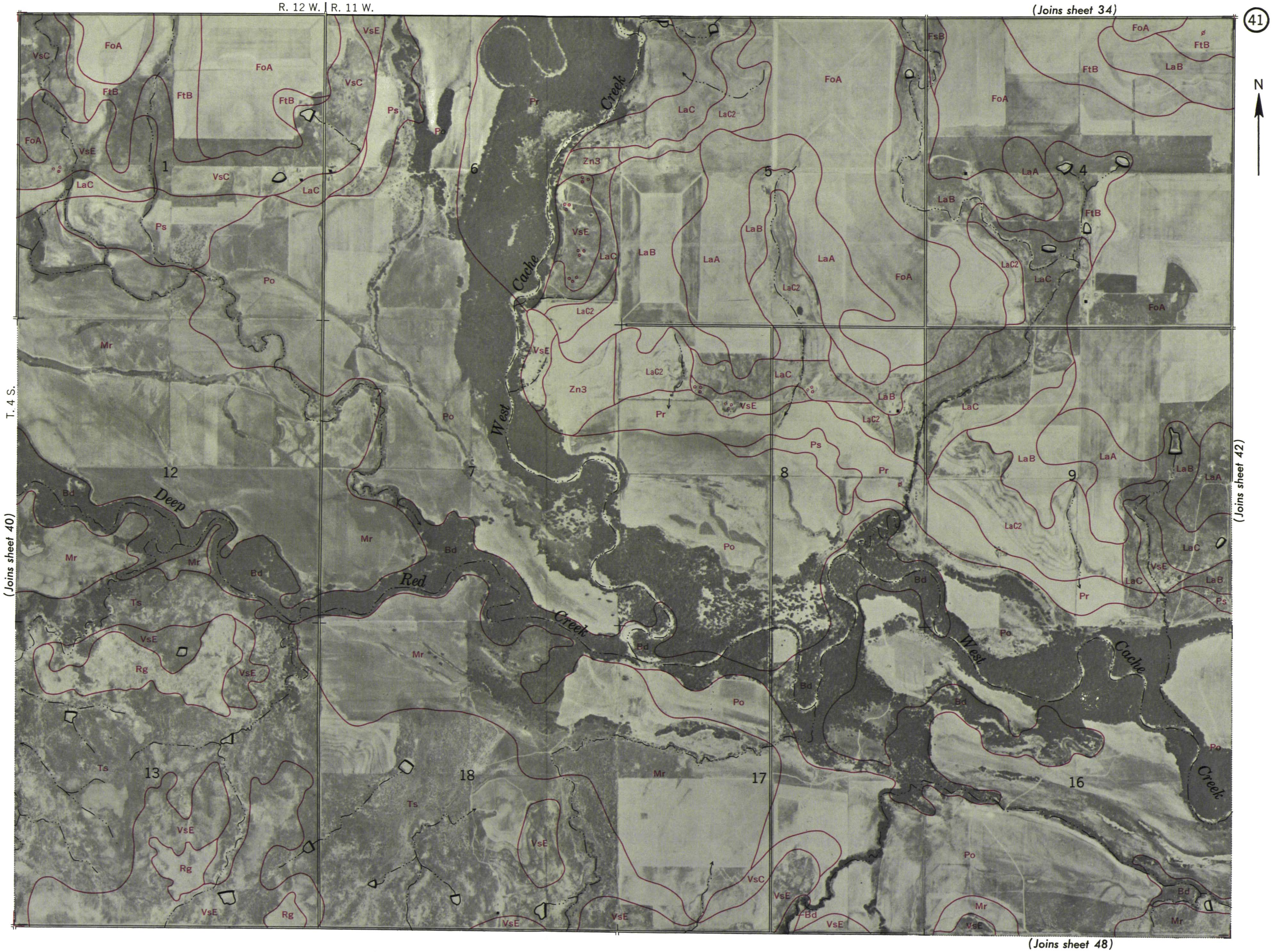
0 ½ 1 Mile Scale 1:20000 0 5000 Feet

COTTON COUNTY, OKLAHOMA — SHEET NUMBER 40





0 ½ 1 Mile Scale 1:20000 0 5000 Feet

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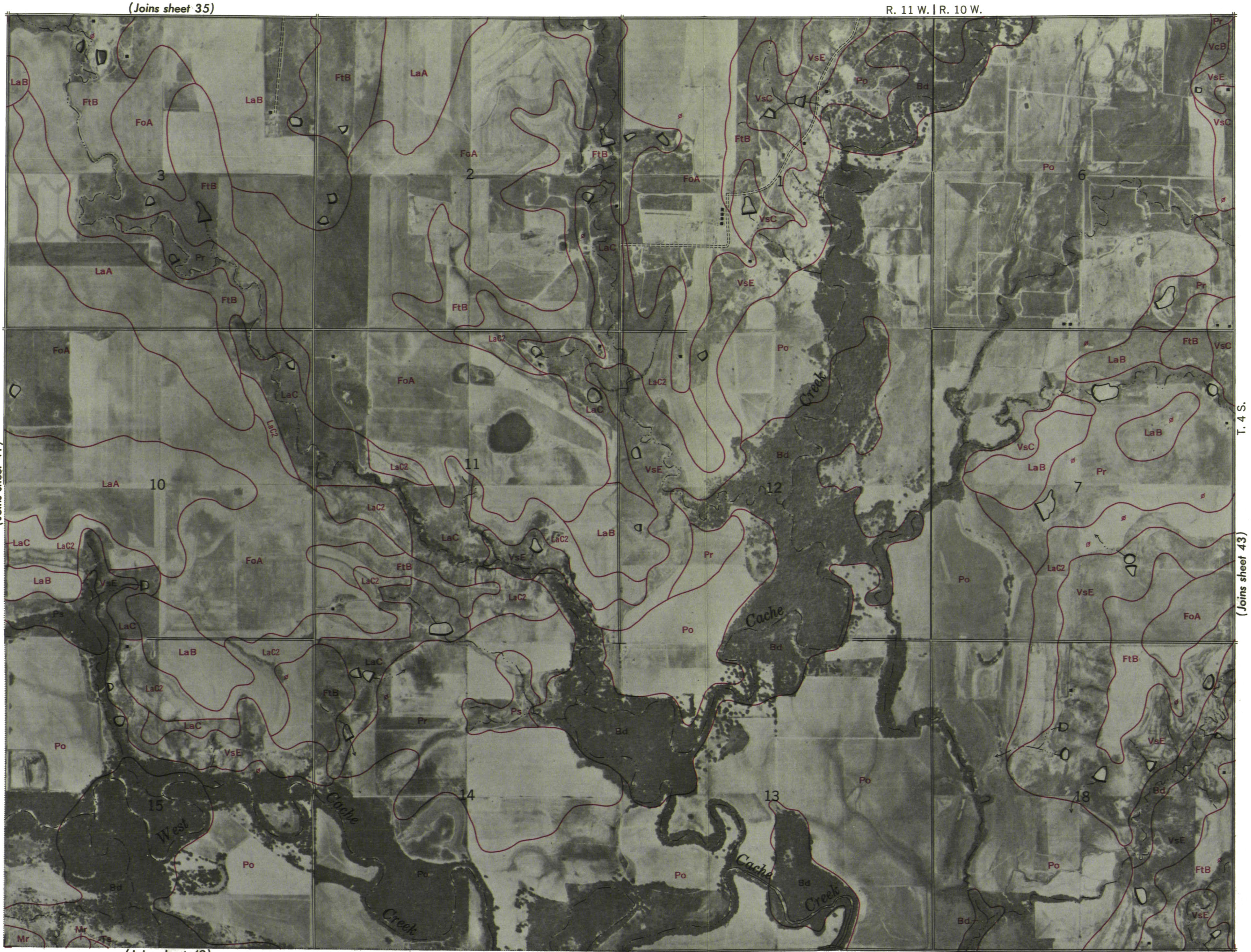
Range, township, and section corners shown on this map are indefinite.

42

(Joins sheet 35)

R. 11 W. | R. 10 W.



T. 4 S.

(Joins sheet 41)

(Joins sheet 43)

(Joins sheet 49)

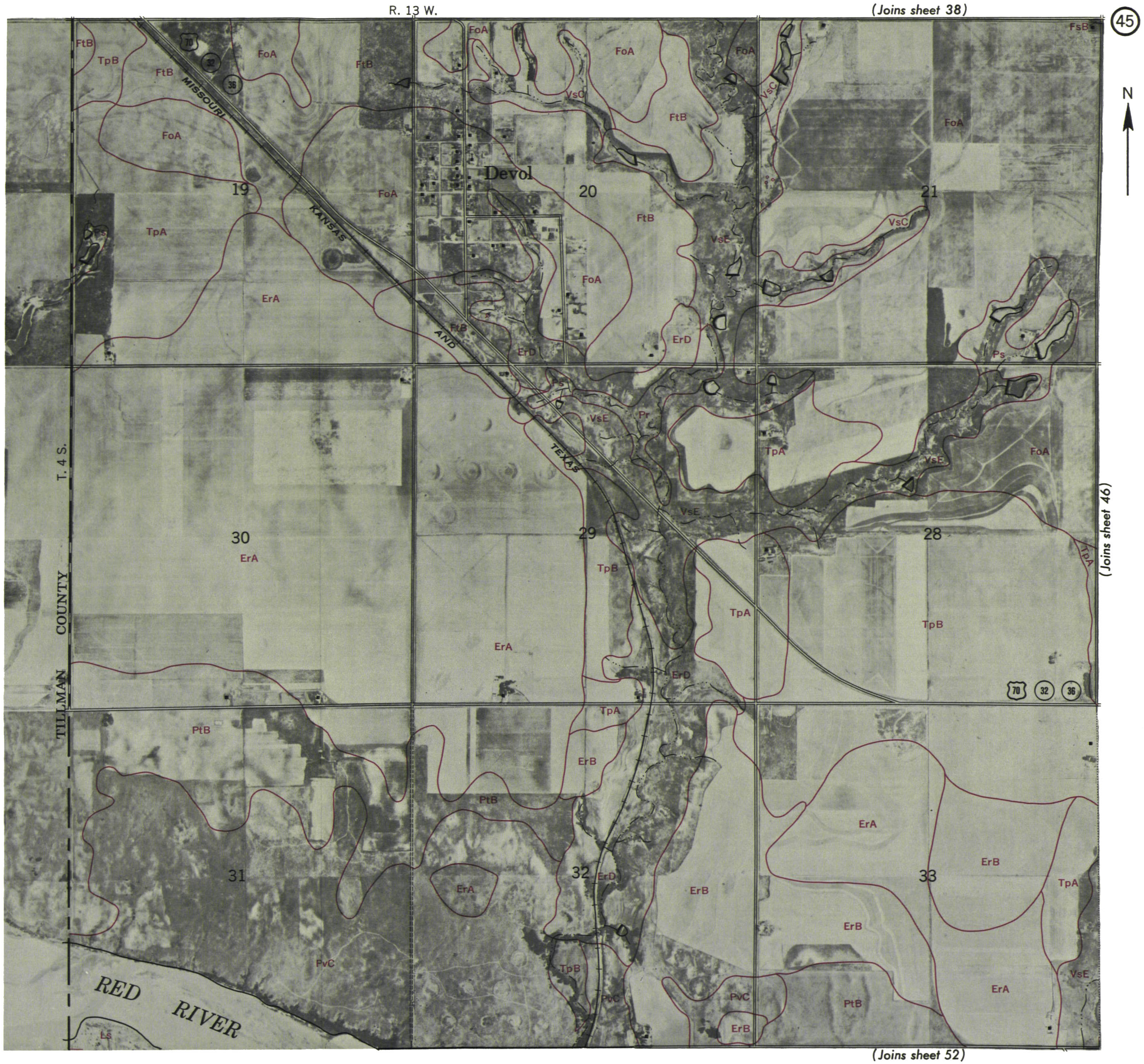
0 ½ 1 Mile Scale 1:20000 0 5000 Feet

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

This map is one of a set compiled in 1962 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Oklahoma Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.


44
(Joins sheet 37)
R. 10 W. | R. 9 W.
N
(Joins sheet 43)
(Joins sheet 51)
T. 4 S.
JEFFERSON COUNTY
CHICAGO ROCK ISLAND AND PACIFIC
Pleasant Ridge School
Whiskey Creek
0 ½ 1 Mile
Scale 1:20000
0 5000 Feet



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

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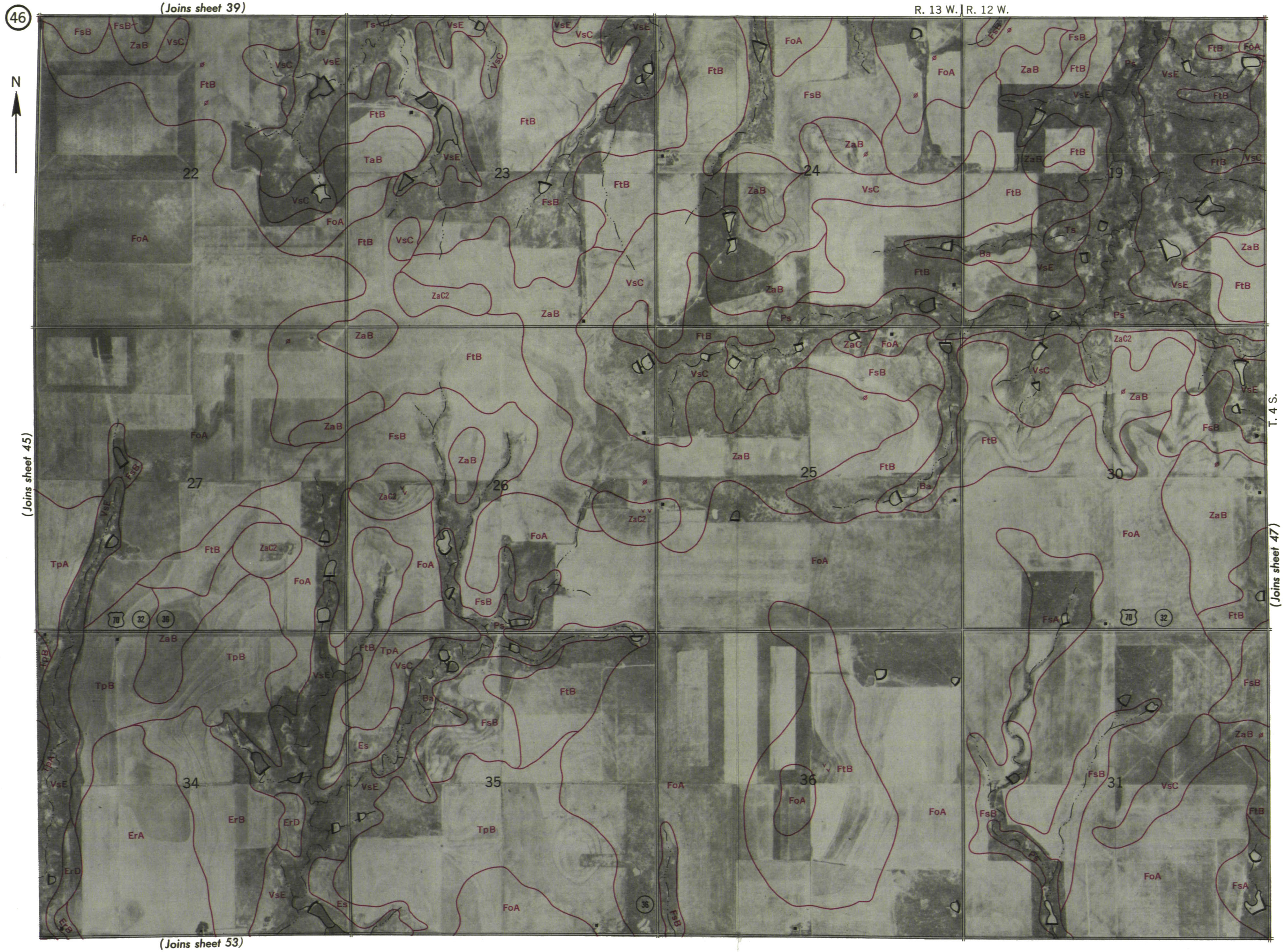
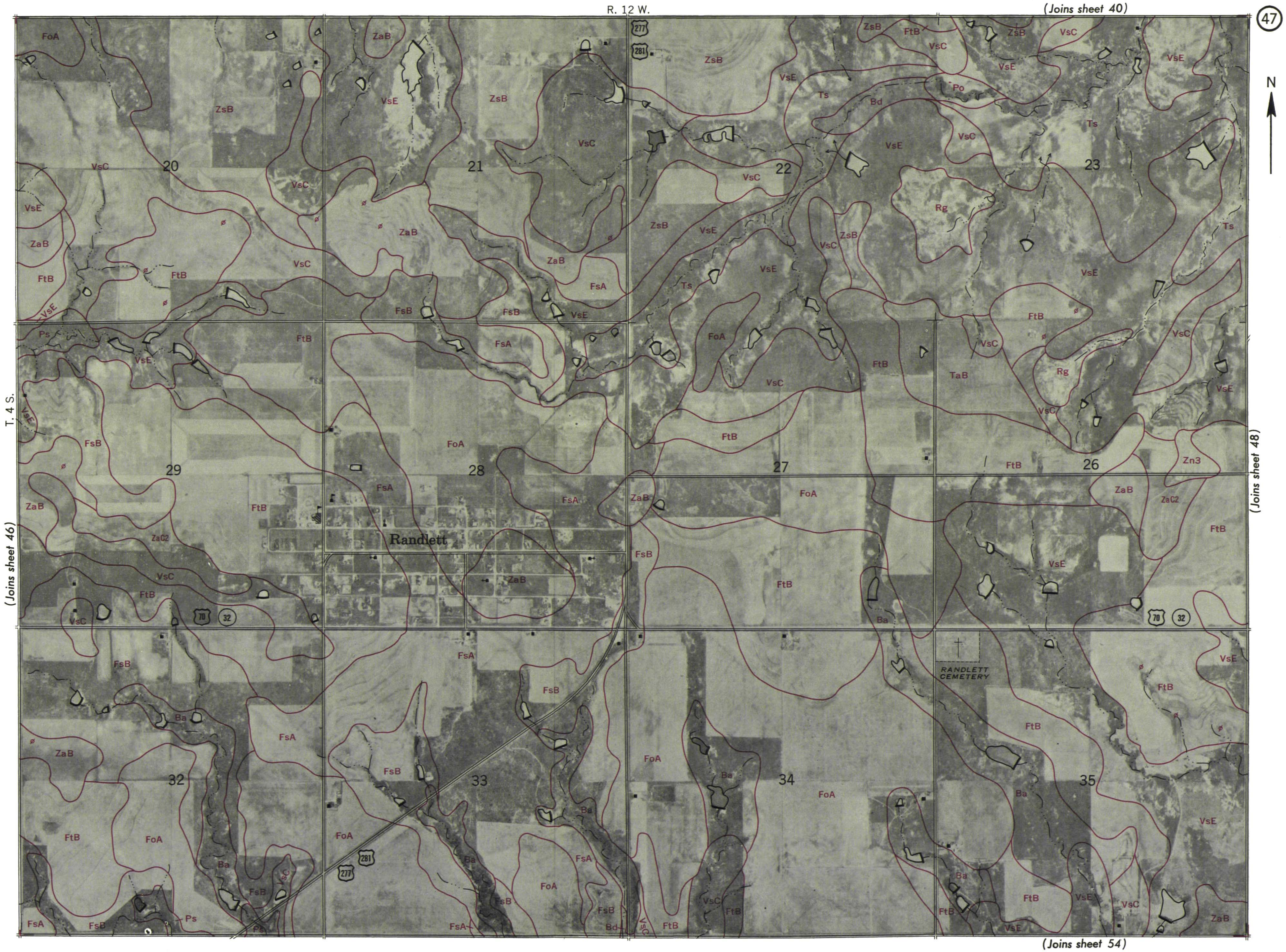


0 ½ 1 Mile Scale 1:20000 0 5000 Feet

COTTON COUNTY, OKLAHOMA — SHEET NUMBER 47

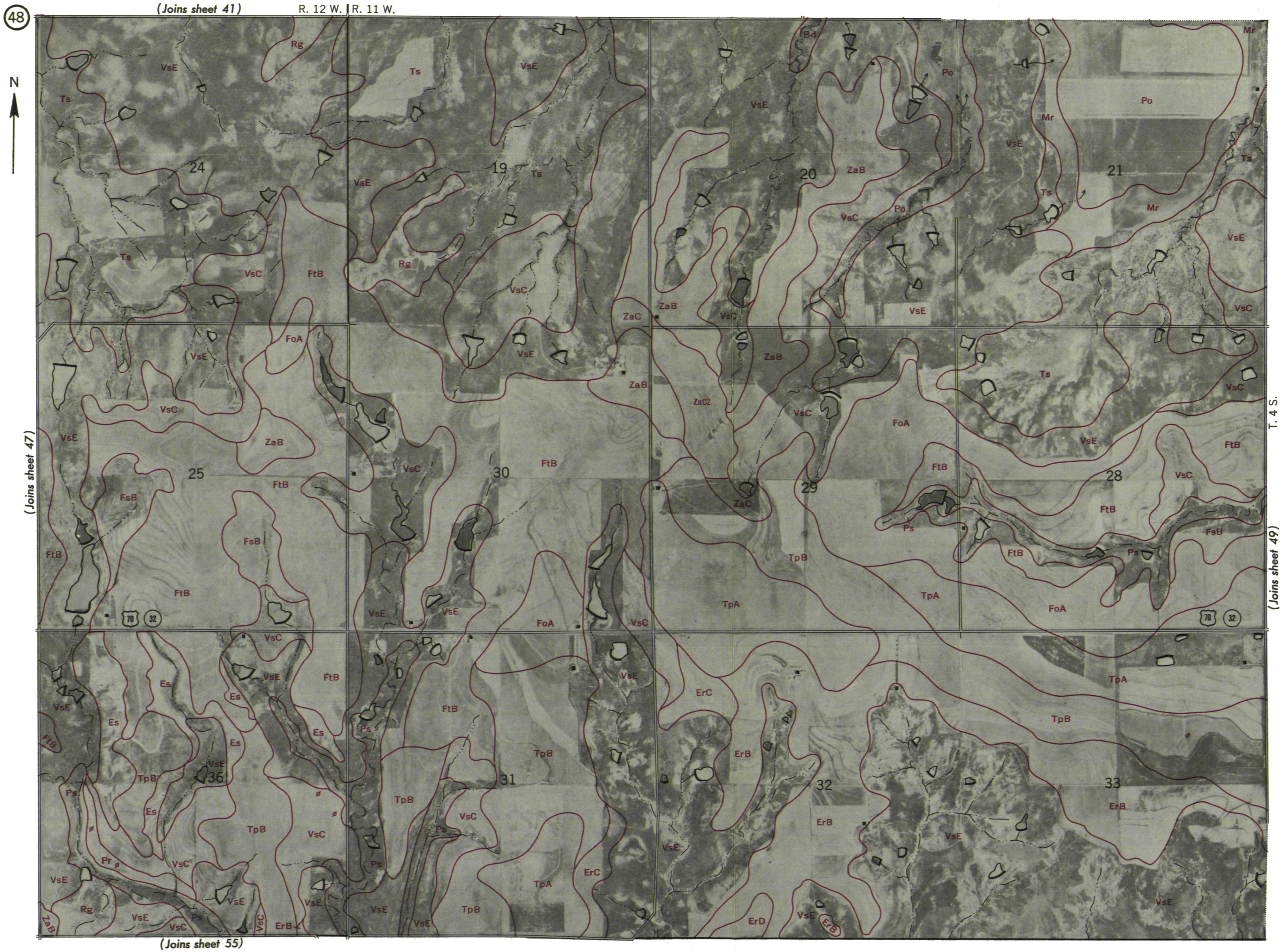


0 ½ 1 Mile Scale 1:20000 0 5000 Feet

This map is one of a set compiled in 1962 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Oklahoma Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

COTTON COUNTY, OKLAHOMA — SHEET NUMBER 48



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

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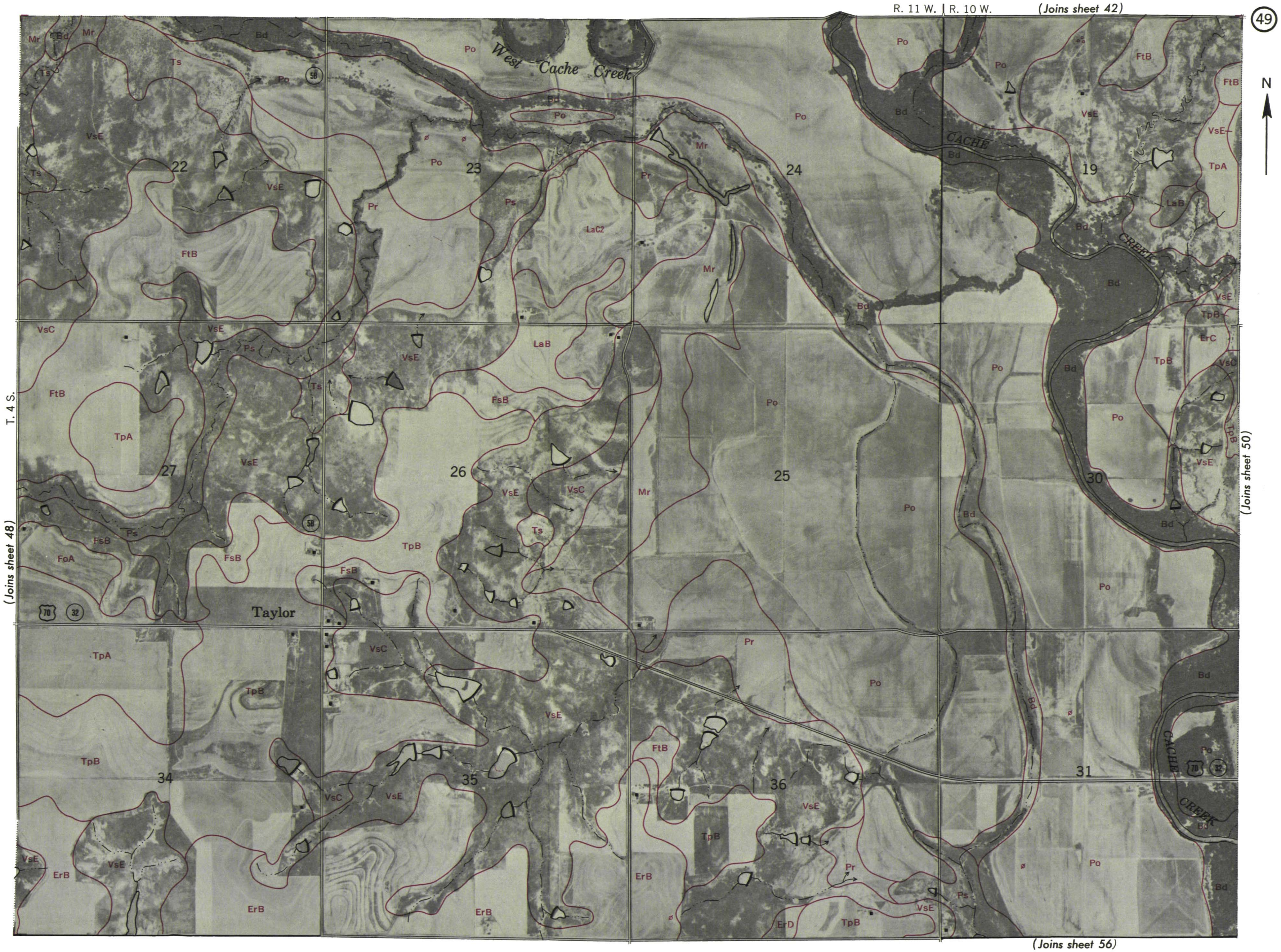
Range, township, and section corners shown on this map are indefinite.



0 ½ 1 Mile Scale 1:20000 0 5000 Feet


50
(Joins sheet 43)
R. 10 W.
N
(Joins sheet 49)
(Joins sheet 51)
(Joins sheet 57)
T. 4 S.
Liberty Hill School
CACHE CREEK
CACHE CREEK
20
21
22
23
29
28
27
26
32
33
34
35
0 ½ 1 Mile
Scale 1:20000
0 5000 Feet

COTTON COUNTY, OKLAHOMA — SHEET NUMBER 51

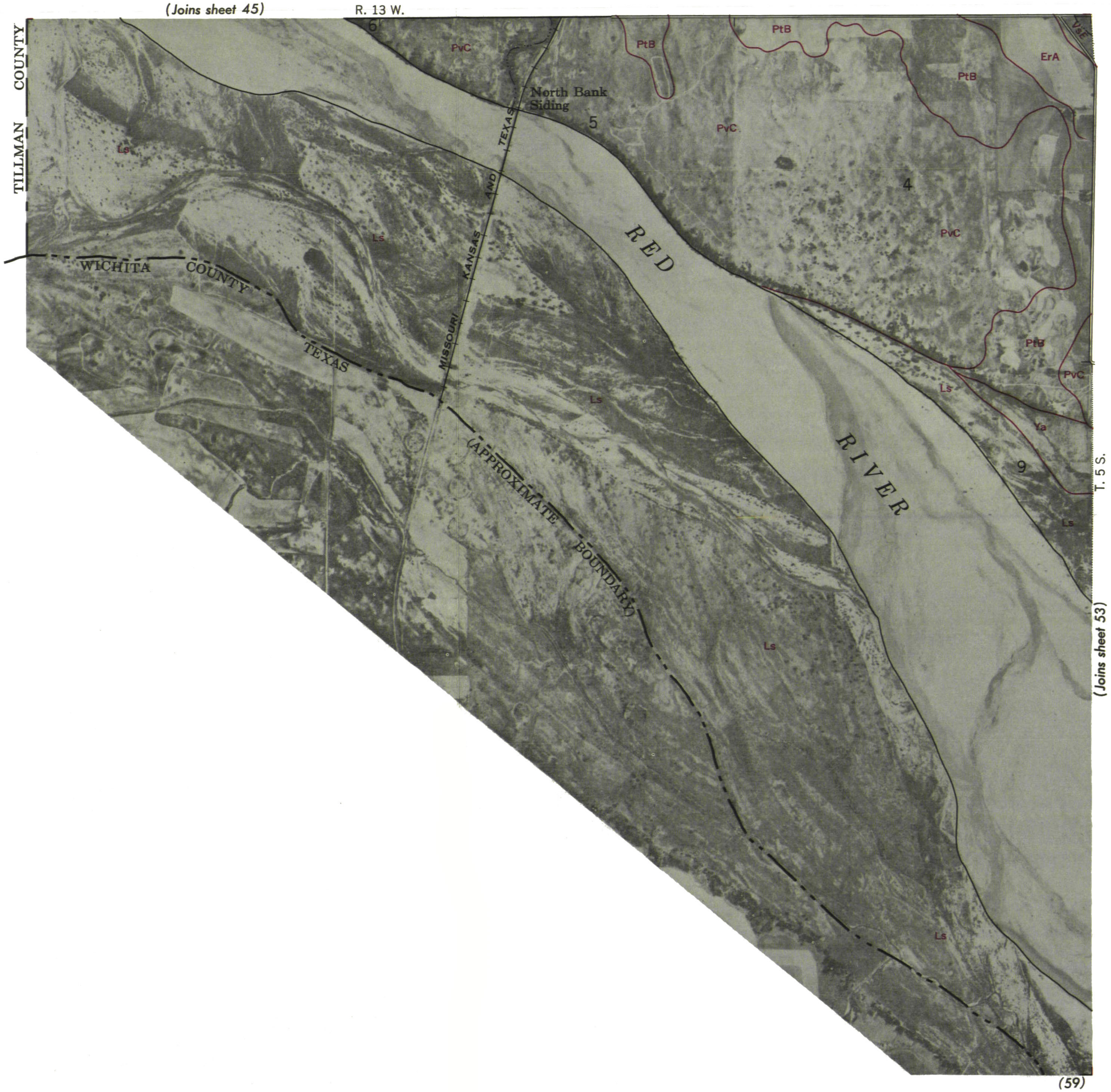
This map is one of a set compiled in 1962 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Oklahoma Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

52

N



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

This map is one of a set compiled in 1962 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Oklahoma Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

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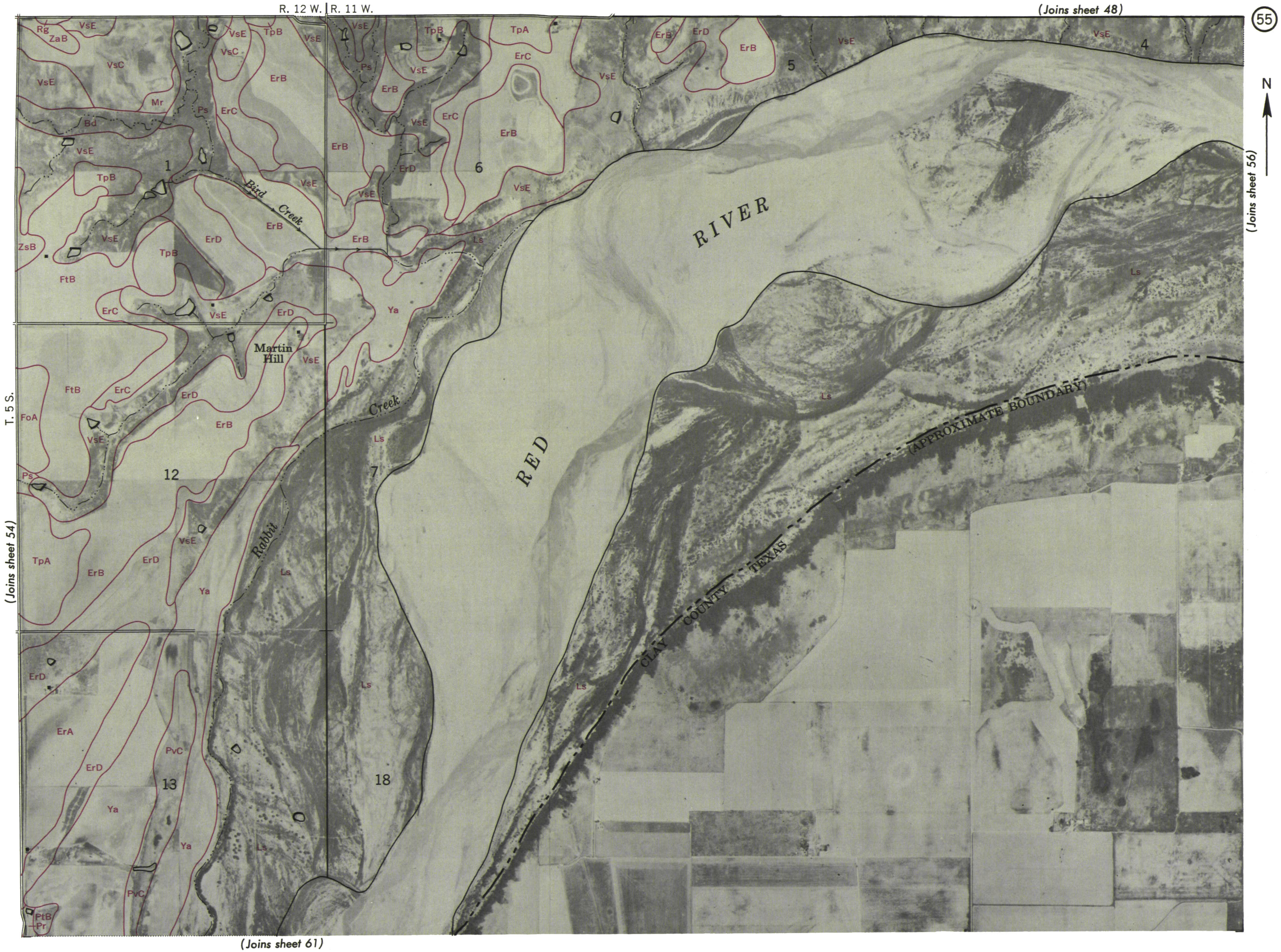


0 ½ 1 Mile Scale 1:20000 0 5000 Feet

COTTON COUNTY, OKLAHOMA — SHEET NUMBER 56

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

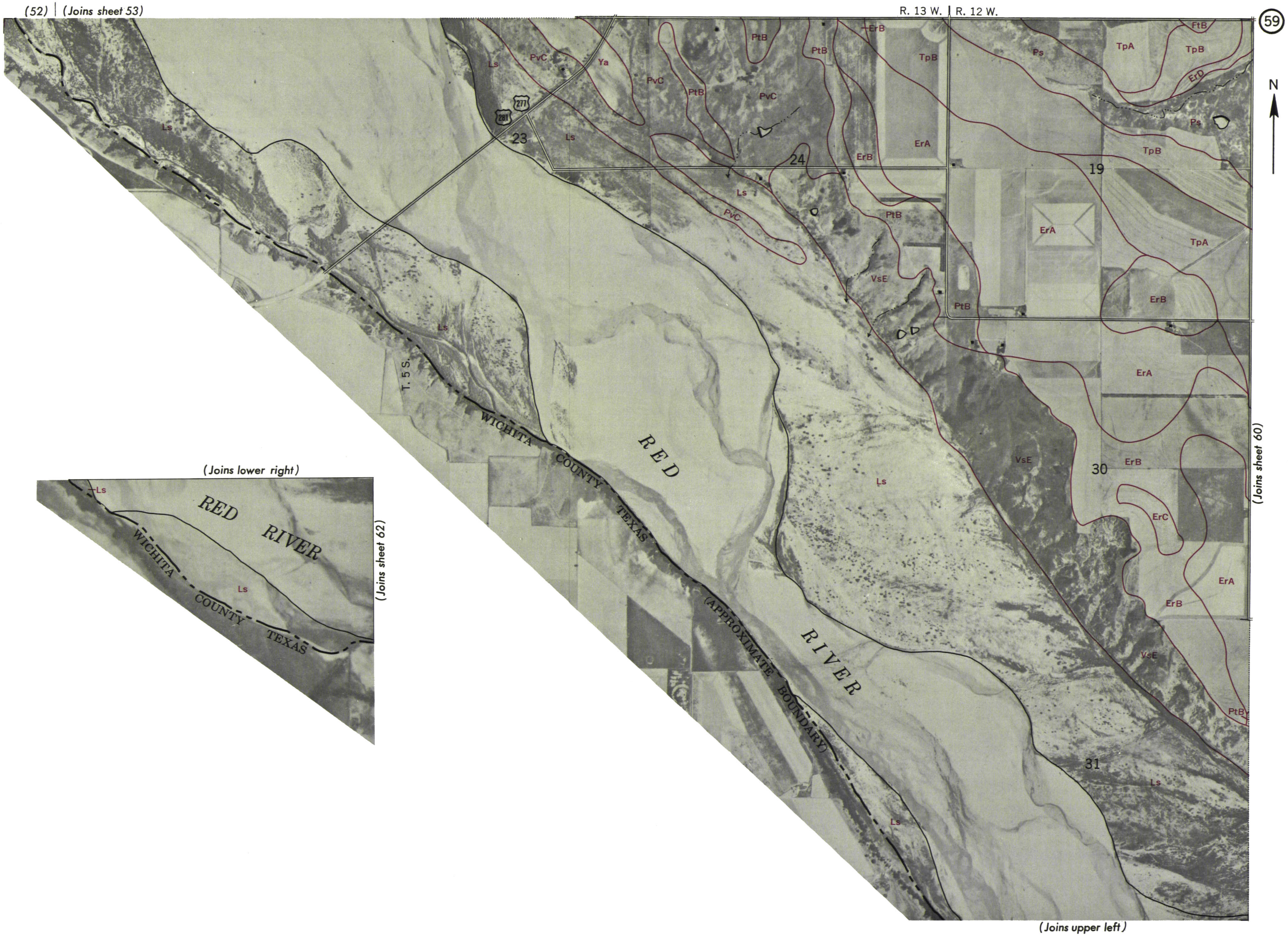
This map is one of a set compiled in 1962 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Oklahoma Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20000 0 5000 Feet


58
(Joins sheet 51)
R. 10 W. | R. 9 W.
N
T. 5 S.
JEFFERSON COUNTY
(Joins sheet 57)
Hooper
Whiskey Creek
RED RIVER
CLAY COUNTY TEXAS
(APPROXIMATE BOUNDARY)
1
4
5
6
7
8
9
12
13
16
17
18
TpB
ErD
Pr
VsE
Bd
Es
VsC
ErB
Ps
ErC
ErA
Po
Ya
PtB
PvC
Ls
0 ½ 1 Mile
Scale 1:20000
0 5000 Feet

COTTON COUNTY, OKLAHOMA — SHEET NUMBER 59

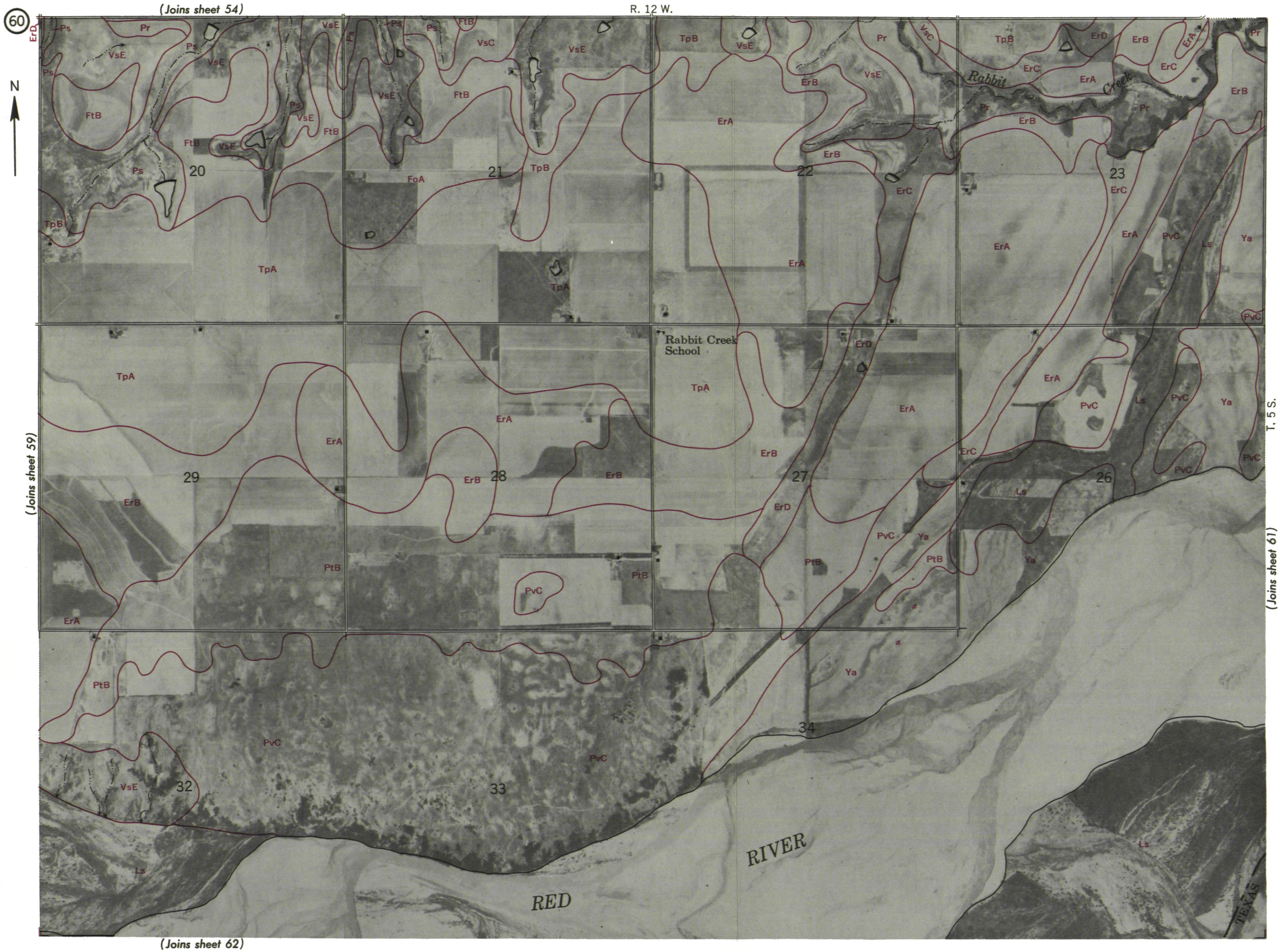


This map is one of a set compiled in 1962 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Oklahoma Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

COTTON COUNTY, OKLAHOMA — SHEET NUMBER 60



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

61

R. 12 W. (Joins sheet 55)

T. 5 S.

(Joins sheet 60)

N

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

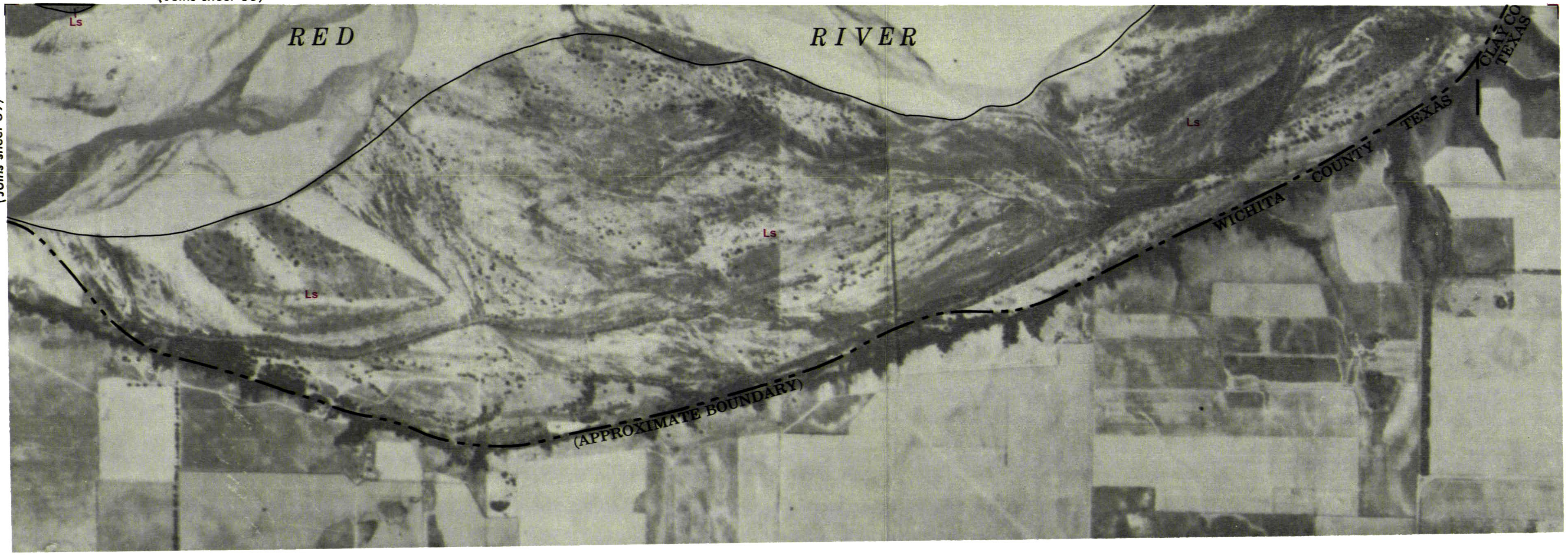
This map is one of a set compiled in 1962 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Oklahoma Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

62

(Joins sheet 60)

(Joins sheet 59)



0 ½ 1 Mile Scale 1:20000 0 5000 Feet